CHAPTER IV.—STEAM VESSELS.

To England and America jointly is due the honor of applying steam practically to locomotion on the sea. There was a time when America led the world in the amount of steam tonnage employed, the vessels of the Mississippi River valley alone exceeding the whole steam tonnage of the British empire; but since that time England has surpassed her, especially in deep-sea navigation, and several other European countries have also become active in that branch of enterprise. America, however, remains the foremost country in the amount of native steam tonnage locally employed. She still builds vessels for transoceanic service, but the number of her vessels actually employed in foreign trade is at present small.

The steam tonnage of the United States comprises 5,139 tugs, yachts, paddle-wheel steamboats, and ocean and lake propellers, aggregating 1,221,206.93 tons register. Fully 2,900 of these vessels are each of less than 100 tons register, being yachts, passenger launches, fishing steamers, small ferry-boats, and tug-boats, the majority tug-boats, of which the enormous commerce of the sea-coasts and lakes has led to a remarkable multiplication. There are only 13 vessels in the whole fleet of more than 3,000 tons register, namely:

	Tons.
Ocean propellers to Liverpool:	
Ohio	3,101
Indiana	3,101
Illinois	3,101
Pennsylvania	3,101
Pacific mail steamers to China:	
City of Tokio	5,079
City of Pekin	5,079
Ocean propellers:	
City of Sidney	3,016
City of Para	3,532
City of Rio de Janeiro	3,448
City of New York	3,019
Alaska	4,011
China	3,836
Solano (paddle-wheel transfer boat)	3,547

About 45 vessels range from 2,000 to 3,000 tons register. They are coasting propellers and paddle-wheel steamboats on Long Island sound and the Hudson river, and comprise also about half a dozen of the larger Mississippi river steamboats. About 250 vessels range from 1,000 to 2,000 tons register, and include the majority of the coasting and lake propellers and the larger steamboats of the West. The remaining 1,900, ranging from 100 to 1,000 tons, are ferry-boats, river steamboats, excursion steamers, tug-boats, and freighting propellers. Of the whole fleet, about 175 are employed on the deep sea and not over 30 in foreign trade.

After the invention of the steam-engine in England the minds of men all over the world turned instinctively to the subject of steam locomotion on land and sea. This idea occurred to a large number of persons at the same time, and ingenious mechanics set their wits to work to devise the means of applying the new power; and it seems to have been the dream of them all eventually to propel heavy ships in calms at sea or against baffling winds, and even to regularly cross the ocean with steam vessels. The first thought of those who attempted to evolve something practical in steam navigation was to tow ships in and out of harbors and rivers, to tow boats on canals, and to propel boats against the current of rivers. Those were the needs of the times. A patent for a steamboat was obtained by Jonathan Hulls in England in 1736 for harbor towing, a small, stern paddle-wheel concern; and experimental boats were tried in England in 1788, 1789, and 1802, two of them for towing on the Forth and Clyde canal. In America a mechanical genius by the name of John Fitch experimented on the Delaware and the Schuylkill in 1786 and 1787 with small steamboats propelled by banks of vertical oars, with which he attained a speed of from 4 to 7 miles an hour, and James Rumsey, another American, tried the plan of forcing a current of water out from the stern of the boat by steam-power. In 1793 Fitch made the first experiment on record with a screw-propeller. He built a long-boat, 18 feet in length, with 6 feet beam, and fitted it up with a crude sort of engine and a screw-wheel at the stern. The boiler was an iron pot with a wooden lid, the two cylinders wood, made like barrels, and hooped with iron, and the pistons were attached to each end of a horizontal walking-beam. The boat was tried on the old Collect pond in New York city, a body of water 60 feet deep, which has since been filled up and given place to solid ground, and on which now stand the Tombs and several blocks of business buildings. A speed of 6 miles an hour was attained with this boat. Various other experiments were made in America on the Hudson and the Delaware rivers, the results of which may be summed up by saying that they proved the impracticability of propelling boats by any appliances other than paddle-wheels and screw-propellers.

The news of the invention of steam towing-boats on the Forth and Clyde canal was a great stimulus to American inventive talent, as it not only urged Rumsey and Fitch to great exertions, but brought out three men of great intelligence, who, after many years of experiment and the loss of a good deal of money, first made steam navigation a success. Robert Fulton, with his partner, Mr. Livingston, and John Cox Stevens, of Hoboken, New Jersey, were these men. Fulton and Livingston first experimented on the river Seine, at Paris, and built two small boats there in 1803, obtaining moderate results only, but fully establishing in their minds the practicability of steamboating. Mr. Stevens spent $20,000 and 13 years' labor in trying to perfect a screw-propeller driven with a rotary engine. In 1804 he constructed a boat 25 feet long and 5 feet wide, with a Watt engine and a screw-propeller, with which he tried to cross the Hudson from Hoboken to New York, and obtained a speed of 4 miles an hour, but the steam-pipe burst just as he was approaching the New York side. He persevered with his boat, however, and finally took it around by sea to the Delaware river, this being the first ocean voyage of a steam vessel on record. This boat was the Phœnix. It is not necessary to recount all the devices tried by Fitch, Rumsey, Evans, Morey, Stevens, Fulton, and other enterprising Americans in that period of evolution of the steamboat; but, it may be repeated, the sum of all their efforts was to prove that boats could not be driven with any mechanical appliances save those of the paddle-wheel and the screw-propeller; the paddle-wheel was preferred, as being simpler.

Fulton's first experiment on the Seine taught him a lesson which has governed the construction of river steamboats in America down to the present time. Vessels were built with light timbers and planking in those early days, and when laden with a general cargo the weights were distributed equally to all parts of the hull. Without foreseeing the consequences, Fulton put into his first boat a heavy engine, which concentrated the weight all at one point, and before the machinery was in working order it broke through the bottom of the boat and went down into the mud of the river. It was afterward raised and used in other experiments, but in later vessels the weights were better distributed. When steamboat building was at length fairly introduced a strong truss of pine braces and iron rods, called the hog-frame, was set up on each side of the long and narrow hulls of the boats, to stiffen and protect them against the weight of heavy machinery.

In 1806 Fulton bought a 20 horse-power engine from Boulton & Watt in England and set out for America to introduce steam navigation to his native land. His original idea was to engage in business on the Mississippi river, and the pioneer boat built by him on the Hudson was intended to be taken around to that great stream of the West. But the West was not yet settled, whereas the Hudson was thronged with a busy traffic, and Livingston and Fulton having secured exclusive rights on the Hudson for steam vessels from the state legislature, it was finally decided to concentrate all efforts on the navigation of the latter river. The Clermont was built by Charles Brown, on the East river, in 1807, and in the latter part of that year she made her first trip to Albany. This was the beginning of practical steam navigation.

"The North River Steamboat of Clermont," for that was her name, was 133 feet long, 16½ feet wide, and 7 feet deep. She was flat on the bottom, with almost perpendicular sides, a bow full, somewhat like that of a river sloop, and had a straight stem; but she was afterward enlarged by being sawed in two lengthwise and filled out, which made her 22 feet wide and 141 feet long. No mechanical drawing of the hull was ever made, but her shape and scantling have been preserved in written memoranda. The bottom was of yellow pine, 1½ inches thick, tongued and grooved, and set with white lead, and having been put together was laid on a platform and floors were laid across edgewise 4 by 8 inches square and 24 inches apart. Under the machinery the floors were of oak, 8 inches square, but at the ends they were of spruce, for lightness. The boat had a bilge log with spruce top timbers. At first there were no guards; consequently there was no support for the outer ends of the axle of the paddle-wheels, and as she was decked only at the bow and stern the boilers were open to view. The wheels were forward of the center of the boat, and were 15 feet in diameter; they had 8 arms, with buckets 4 feet long and 24 inches dip. The shaft was of cast iron, 4½ inches in diameter. The boat also carried a heavy fly-wheel 10 feet in diameter, hung outside of the boat and extending below it. This attachment was an inconvenience in shoal water, and was afterward discontinued. The boiler was 20 feet long, 7 feet deep, and 8 feet wide, and drove an engine whose cylinder had 24 inches diameter and 4 feet stroke. Afterward strong guards were built on the boat to support the wheels, and a house was put upon them to keep the spray from dashing on board the boat, which it did copiously at first, to the discomfort of all. This boat drew 28 inches of water.

The first trip of the Clermont made a great sensation at New York city and all along the river, and great crowds came to witness her departure and her voyage up the river. The boat made the first 110 miles in 24 hours, and ran the whole distance of 150 miles in 32 hours; but omitting the time spent in landings the voyage was made in 28½ hours, an average of 5 miles per hour. The Clermont was a success from the start, and immediately excited a feeling of intense hostility all along the river. The Hudson at this time was thronged with a multitude of sloops, packets, and freighting boats, by which the whole of the traffic between New York city and the interior of the state was transacted. The packets would clear from Albany one day, discharge and load at New York the next, set sail on the third, and arrive in Albany again on the fourth. Some of these boats were excellent vessels. For instance, in 1806 a stock company had been formed for the purpose of expediting travel on the river, and the sum of $6,000 having been subscribed, the sloop Experiment, of 110 tons, was built and superbly fitted with state-rooms and berths throughout her whole length below deck. In 1807 the company raised $6,000 for a second sloop.

These boats made the trip to Albany in 27 hours, at a cost to the passenger of $5. Similar vessels were engaged in the trade of the river, though no others were so large. Fulton's daring experiment of steam navigation was therefore, in substance, a bold attack on a vested interest, and there was intense feeling against him on the part of all the river men. Their hostility was practical, too, and put him to a good deal of trouble and expense, as sloops constantly got in the way, and frequently ran against the Clermont boldly, with the design of smashing the paddle-wheels. Fulton was not the man to be daunted by warfare like that, but persevered, and made his operations a triumphant success. During the winter of 1807 the boat was laid up, enlarged as before stated, and launched again, and in 1808 she was constantly engaged in making trips to and from Albany, and always went full of passengers.

In 1808 Charles Brown built the Raritan, of 120 tons, designed by Fulton's own hand, and the Car of Neptune, of 295 tons. The latter was 157 feet long on the bottom, 171½ feet on deck, 22 feet broad on the floor, and 26 feet on deck. The Paragon, of 331 tons, was built in 1811. In 1812 the Firefly, of New York, was built to run to Newburgh, and a ferry-boat of 118 tons was built to ply to the Jersey shore. It was Fulton who designed the double-end ferry-boat with dropping bow and stern, which has ever since remained in use.

The war of 1812, which broke out at this stage of the development of steam navigation, did not interfere with the progress of experiment. In fact, it was the cause of a step in advance on the part of America, as it suggested to the fertile mind of Fulton the idea of the first steam war vessel in the world. He proposed to the government a floating battery, with guns pointing in every direction, which would steam at the rate of 4 miles per hour and cost the sum of $320,000, about the amount a first-class frigate could be built for. The offer was accepted, and the vessel was built in 1814. She was 156 feet long, 56 feet broad, and 20 feet deep. The paddle-wheel was 16 feet in diameter, and was hung in the middle of the hull, as in some of the modern western river ferry-boats. The buckets were 14 feet long, with 4 feet dip; the boiler was 22 feet long, 12 feet broad, and 8 feet deep, and the cylinder 48 inches by 5 feet. Tonnage of the vessel, 2,475; draught of water, 10 feet. The walls of this steamer were 5 feet thick, and she was in every respect a formidable ship. Her speed was 5½ miles per hour. This powerful battery gave great satisfaction to the naval authorities, and had a surprising effect on the imagination of people abroad, who published the most extraordinary reports of her powers. It was declared in England that she could discharge 100 gallons of boiling water per minute, brandish 300 cutlasses by machinery over her gunwales, and dart out 300 iron spears from her side every quarter of a minute. She was destroyed by an explosion of her magazine in 1829.

The model of the original North River boats resembled that of a sloop or an immense skiff. They were at first decked only a short distance at the stem and stern, but afterward the whole length of the boat was decked. The engine was open to view. Away aft was a house very much like that of a modern Erie canal-boat, which was raised to cover the boiler and to serve as a shelter to the apartments for the officers, and it was in this part of the boat that the passengers were accommodated. As in the Clermont, the boiler was of the form usual in the Watt's engine, and was set in masonry. The wheels at first were without houses, and when the breeze was brisk the spray from them dashed aboard and made the boat wet. The cross-heads connected with the piston instead of the walking-beam now in general use. The fuel used was wood, some of it cut from the public commons; and a correspondent writes to an Albany paper of those early days complaining bitterly of the enormous consumption of wood by the two steamers Fulton was then running. He placed the value at $5 a cord, and stated that the boats consumed thousands of dollars' worth per annum. The cost of fuel was then the principal item in the cost of running boats. At first it was $150 per trip; but Lackawanna coal, used first on the Car of Neptune in 1816, reduced the expense to $30, and this was regarded as the commencement of a new era in steam navigation.

Fulton and Livingston had a monopoly of the river for a few years; but in a short time the traffic was thrown open to the competition of all, and boats were built by different persons as fast as the trade of the river would warrant it.

As speed was an important element in travel, the steamboats built by opposition lines began to race with each other as early as September, 1809, the first race on record taking place in the month referred to between Fulton's boat and one built by an Albany company. The Albany vessel had advertised to leave at the same hour with Fulton, and the coming race was the exciting topic of that year. The friends of Fulton were led by Professor Kemp, of Columbia College; those of the Albany boat by Jacob Stout. The boats raced down the river and victory was long in suspense, and it was not until after the thirtieth hour of the race that Fulton's boat fairly led.

For many years Charles Brown built nearly all the Hudson River boats, but when this new form of carrier became an assured success other builders devoted their attention to the same class of vessel. New York was the principal center of steamboat building, but vessels were also constructed at Newburgh, as well as at Philadelphia and Baltimore, for the navigation of the rivers of those regions. Very few of these boats were less than 100 feet long, and the great majority were from 120 to 180 feet.

The desire for speed and light draught on the Hudson led to many changes in the forms of boats, the most striking of which were in the proportions of breadth to length. The early boats had about 18 feet beam, and were from 6½ to 9 times as long as they were broad. In the Car of Neptune the proportion was 7.8. By giving the vessels greater beam, namely, from 20 to 24 feet, and occasionally 26 feet in place of 18, they secured lighter draught, which was of the first importance in navigating shallow rivers. At New York the proportion of length to breadth was from 5 to 7; at Philadelphia and Baltimore from 4 to $6\frac{3}{4}$. The depth of hold was from 7 to 9 feet, and the draught of water from $4\frac{1}{4}$ to 7 feet, but some of the fastest boats drew 6 feet. When light draught had been duly obtained by widening the beam speed was secured by again lengthening the hull and adopting a rounder midship section. A beam of from 22 to 24 feet was retained for the Hudson river service, but the length was increased until it was from 8 to $10\frac{1}{2}$ and occasionally 12 times the breadth. The Albany, built in 1832 at New York, was 272 feet long, $26\frac{1}{6}$ feet beam, and $8\frac{1}{3}$ feet deep in the hold, registering 588 tons; the Swallow, built in 1836 at New York, was 225 feet long, 23 feet beam, and $8\frac{1}{3}$ feet deep in the hold, and registered 426 tons; the Home, a New York boat, built in 1837, was 211 feet long by $22\frac{1}{2}$ feet beam and $11\frac{1}{3}$ feet depth of hold, and was of 537 tons register; and these were large and fast boats for their times. It is to Robert L. Stevens that the Hudson river is chiefly indebted for its clipper steamers. He paid much attention to the subject of speed, and secured the object by improving the steam-engine and by making the bow and run of the boats sharper and longer than ever before attempted. Some of the early steamers were lengthened by being hauled ashore, cut in two, and having 25 or 30 feet added to their middle. False bows 20 feet long were put on other boats, and after 1830 new boats were frequently built with solid ends so keen and sharp that they parted the water without raising a ripple or throwing scarcely any spray. In later years a speed has been attained of from 20 to 28 miles per hour.

The boats built to traverse Long Island sound were broader and deeper than those of the river, as they had to encounter boisterous winds and heavy swells. The following are the register dimensions of a few of them:

Year.	Name.	Where built.	Length.	Breadth.	Depth of hold.	Tonnage.
			Feet.	*Feet.*	*Feet.*	
1835	Benj. Franklin	New York	160	$31\frac{1}{2}$	10	408
1835	President	do	$183\frac{3}{4}$	$32\frac{1}{2}$	11	615
1836	Massachusetts	do	202	29	12	676
1836	Narragansett	do	$212\frac{1}{2}$	27	$10\frac{1}{3}$	576
1836	Rhode Island	do	212	$27\frac{5}{6}$	$10\frac{1}{3}$	588

The engines placed in the early boats were of small power proportionate to tonnage. In the Clermont the power was one-eighth of the tonnage, and this was about the proportion in all the early boats; but twenty years afterward it was one-fifth the tonnage, and still later the engines were more powerful yet.

It is surprising how quickly steamboats sprang into existence in different parts of the world after the building of the Clermont, one being built on the Saint Lawrence in 1809, and a second one in 1813. Abroad, the success of Fulton created great excitement, the English people being especially inspired by it. They built their first steamboat at Glasgow in 1811, and several others at various ports within a few years afterward, and then pushed forward in general navigation with energy. They directly encouraged the builders by large orders for the navy, and in 1839 England had 96 war steamers in use, America having only built one. Other countries followed. The first steamboat on the Mississippi was built in 1811.

Having no rivers of great length, the English were compelled to adapt their boats to deep-sea navigation. The Americans, on the other hand, devoted their talents chiefly to the problems of smooth-water navigation and to conquer the wilderness through which the rivers extended, as well as to build the boats required for inland trade. Besides, there was no impulse in that period to send out steam into the deep-sea trade, for the country had an abundance of the fleetest and finest sail shipping in the world.

Fulton employed the ordinary paddle-wheel from the start—a large, light, double wheel, carrying boards, fixed on the outer ends of the spokes, about 4 feet long and dipping 26 inches into the water. Builders were never quite satisfied with that wheel, because the buckets struck and left the water in such a way as to lose a great deal of power. An astonishing number of inventions were patented from 1807 for forty years afterward intended to introduce a better wheel. One object striven for was to make the buckets movable, so that they would enter, pass through, and leave the water in a vertical position. Theoretically, this would be a perfect paddle-wheel, but the device could never be made strong, light, and satisfactory. A great deal of money was lost from time to time by inventors in experimenting with the idea; several tried to feather the paddles. All sorts of shapes in buckets were also tried. They were patterned after fishes' tails, ducks' feet, and birds' wings, and were made of various triangular forms, with the pointed end outermost in some wheels and the base of the triangle out in others. Few of these multifarious devices were ever put to use, and none ever stood the test of more than a year or two. The ordinary paddle-wheel has not been superseded in river steamboats to the present day, and its defects were overcome as far as possible in the later boats, especially after 1835, by the introduction of narrower paddles and larger wheels, the diameter of some wheels being from 40 to 46 feet. Huge houses were built to shelter these enormous wheels, and were thereafter a feature of all American river boats. The popular diameter to-day in Hudson River and Long Island Sound boats is 40 feet. Large wheels enable the buckets to enter and leave the water in nearly a vertical position, so that there is less concussion when they strike and less water is lifted when they emerge. For the same reasons small buckets are better than wide ones; in many of the early boats the buckets were too wide and had to be changed.

While the paddle-wheel was developing in America the screw-propeller was coming into commercial use. Little attention had been paid to the subject of the screw here after the first experiments by Fitch and Stevens. In England they needed something better than paddle-wheels for a vessel, rolling and pitching on the open sea, and in 1825 a premium was offered for the best device for propelling a ship without paddles. In response a naval officer invented a screw with two blades projecting from an axis at an angle of 45°, and one or two boats were fitted with it. Engineers strongly advised the perfection of the screw, and in 1836 two practical inventions were brought out, one by F. P. Smith, of London, and one by Captain John Ericsson, of Sweden, then resident in London, that of Smith being on the principle of the Archimedean screw, a spiral wrapped around an axis. The propeller of Mr. Smith was 2 feet in diameter, with a pitch of 29 inches; the diameter of the shaft was 6 inches, and the length of stroke 15 inches. The screw consisted of two turns of a single blade on a long axis, and it was tried on a little 34-foot boat, having 6½ feet beam and 4-foot draught, which was taken out to sea, and made an average of 8 miles an hour. In the first experiment with this boat on a canal it is said that a part of the blade accidentally broke off, when she "immediately shot ahead at a sensibly greater speed". A stock company was formed to test this propeller, and in 1839 a vessel was built, called the Archimedes, which was 125 feet long, 106¾ feet long between perpendiculars, 21$\frac{10}{12}$ feet extreme breadth, and 13 feet in the hold. She drew 9½ feet of water, and was of 237 tons register. The stern was given an extra amount of overhang, so that the rudder might be fitted aft of the screw and the stern protect them both. Her propeller was at first a single-bladed screw 5 feet 9 inches in diameter, with 8 feet pitch, making one complete turn on the axis; but this was afterward taken off and replaced by one with two blades, each making a half turn around the axis. The trials with this boat in 1840 aided to bring screw propulsion into more general notice. The Archimedes sailed around England and Scotland, calling at many ports *en route.* Many subsequent experiments were made, both with this vessel and with Mr. Smith's double screw of two half-threads; but this special form of propeller never attained any commercial value, and a successful introduction of the new mode of propulsion was effected by Captain Ericsson.

The first practical screw vessel was the Francis B. Ogden, a wooden boat specially built to test the Ericsson propeller, which was first tried on the Thames in April, 1837, and was 45 feet long and 8 feet broad on the beam, drawing 2¼ feet of water. Mr. Ogden, the American consul at Liverpool, being among the first to perceive the advantages of the propeller as operated by Captain Ericsson, entered into an arrangement with the inventor to secure an interest in his patents in the United States, and in appreciation of his encouragement Captain Ericsson's first vessel was named after him. The boat was fitted with two propellers, each 5 feet 3 inches in diameter, consisting of a short hub or cylinder of iron, to the periphery of which were fitted several blades having a spiral twist. The performances of this vessel were remarkable, as a speed of 10 miles an hour was attained from the start and surprising power was developed. This little boat towed a schooner of 170 tons at a speed of 7 miles an hour, and an American packet ship, the Toronto, was towed up the Thames at the rate of more than 5 miles per hour. In spite of these successes, the engineers of London did not regard the screw with favor; and although one day, for the purposes of experiment, the little boat took in tow the admiralty barge with a distinguished company of lords and scientific men on board and drew it through the water at the rate of 10 miles per hour smoothly and noiselessly, the admiralty refused to encourage Captain Ericsson, on the ground that it would be impossible to steer vessels driven by his propeller. Ericsson wanted to build a war vessel for the English navy, but fortunately for America he failed to secure an order.

Captain Robert F. Stockton, of the American navy, was in London in 1837, and through Mr. Ogden became acquainted with Captain Ericsson. Having made an experimental trip in the Ogden on the Thames, he at once saw the importance of screw-propulsion, and immediately gave the Swedish engineer an order for two iron boats for the United States with steam machinery and propellers of Ericsson's own design. These vessels were ordered entirely on Captain Stockton's private account, so as to bring the subject of screw-propulsion before the attention of Americans. One of the boats built by his order was the Robert F. Stockton. She was built of iron by the Lairds of Birkenhead, and was launched in 1838. Her dimensions were: Length, 70 feet; beam, 10 feet; depth of hold, about 9 feet; draught, 6¾ feet. The two propellers, 6⅓ feet in diameter, were placed directly aft of the stern-post and forward of the rudder, the two screws being in line. The Robert F. Stockton was tried first as a steamer, in which capacity she made 11 and 12 miles an hour; and afterward as a tow-boat, with four square coal barges in tow, she made 5½ miles per hour. The trials proving satisfactory, the vessel was rigged as a two-masted topsail schooner and sent to the United States under sail in charge of Captain Crane, an American, with a crew of four men and a boy, and was the first commercially successful screw-steamer and the first iron vessel to cross the Atlantic. In 1840 the Stockton was sold to the Delaware and Raritan Canal Company and her name changed to the New Jersey, and for many years she was employed on the canals and the Delaware and Schuylkill rivers as a tug-boat. The screw was thus practically introduced in America by Captain Stockton, and sprang into favor at once. A great many vessels were built with that form of wheel, and in less than ten years after 1839 there had been 150 vessels built in America and fitted with screw-propellers.

Captain Ericsson remained in London to push his invention into commercial use. The Novelty, a freight boat for the London and Manchester canal, and the Enterprise, a canal passenger boat, had been built and fitted with his propellers, and had established the practical utility of the screw before the Archimedes was constructed for Mr. Smith. The Enterprise was subsequently employed with success as a tug-boat on the rivers Mersey and Trent.

Captain Stockton was so sanguine that he could induce the United States to adopt the screw for the navy, and Captain Ericsson was so confident that this would be done, that the latter resigned his professional engagements in London and in 1839 came to the United States. In spite of the experiments of Mr. Smith popular interest in screw-propulsion was very faint in England after 1839, and it was not until after the Americans had put the new idea into extensive use both on the ocean and on the northern lakes that England awakened to its advantages. The Archimedes was successful in 1840; but in 1841 only three English merchant vessels had been fitted with screw-propellers, and it was not until 1843 that the frigate Rattler was converted to a screw steamer. On the other hand, by December, 1843, forty-two vessels in America had been fitted with screws, including the Vandalia (1841) and nine other lake propellers, four for the Hudson river, four for Long Island sound, a number for the coasting service, and a number in Canada.

Captain Stockton had been finally successful in inducing the United States government to build one of three war-ships ordered in 1839 as an Ericsson propeller, and through his efforts the Princeton was fitted with a screw and with machinery placed below the water-line. She was the first war vessel of her class on the face of the earth. She was 164 feet long, 30½ feet in beam on deck, and 21½ feet deep in the hold, had two decks, and weighed, when launched, 418 tons gross. Her deepest draught with 200 tons of coal on board was 19½ feet, her mean draught 17 feet, and her register capacity was 673 tons. The Princeton was built with a flat floor amidships, with a sharp bow and great leanness aft. The stern-post was given the unusual thickness of 26 inches at the propeller shaft, tapering above and below, and the stern overhung 15½ feet. Hanging from it was a wrought-iron rudder-post, so placed as to leave 6 feet in the clear between it and the stern-post, heeling on an oak extension of the keel. The rudder was framed of iron, filled in with oak plank, being in all 5⅝ inches thick. The propeller was Ericsson's peculiar idea. It had a brass drum 8 feet in diameter, with 6 brass blades riveted to it, having a true helicoidal twist. The extreme diameter of screw was 14 feet, the pitch 35 feet, and the length in the direction of the axis 2 feet, and the whole wheel weighed 12,000 pounds. The Princeton cost $212,000, and was a successful steamer, making 13 miles an hour on her trial trip. She was full rigged as a ship, and saw a great deal of sea service, visiting the Mediterranean, taking part in the Mexican war, and sailing to other parts of the world.

It is not certainly known where the screw-propeller was first adopted in America for tug-boats, but it appears from the records that the iron tug R. B. Forbes, of Ericsson's design, was built at East Boston as early as 1845 and was supplied with twin screws, working in opposite directions. This tug was a large boat of about 300 tons burden, was especially adapted for outside work in rough water, and lived long enough to be bought by the government during the last war and to take part in the capture of Port Royal. The screw was adopted for towing at Philadelphia in 1849. Some one in that city who had two towing boats of the old paddle-wheel type saw the advantage of propeller tugs for harbor and canal use when he saw the Robert F. Stockton towing 4 coal barges at the rate of a mile in 11 minutes. The first propeller tug-boat built on the Delaware was constructed by William Cramp, of Philadelphia, and was fitted with engines made by Jacob Neafie. She had a wooden hull 80 feet long, 17 feet broad, and 8 feet deep. This boat did excellent service on the Delaware, and her success brought a great deal of business to her enterprising builders. It was thought at first that the entire screw should be below the hull of the vessel, in order to exert its full power; but Mr. Cramp departed from that idea and fitted the Sampson with a 6-foot wheel, only half of which was below the hull, and with a 3-foot keel to protect the screw. After a number of boats had been built of that style some one wanted a light-draught tug, and the broad keel was then removed and the wheel placed entirely above the bottom of the vessel. This boat proving to be as efficient as its predecessors and much more handy, a revolution was effected in the form of tugs. The screw has now superseded the side-wheel for towing purposes, and at the present time there are more than 1,800 of these admirable boats in use in different parts of the United States, chiefly in the sea-coast harbors and on the northern lakes. It is remarkable that in England paddle-wheel towing-boats have lingered in use down to the present time. The tug of our American harbors is a little propeller varying from 30 to 120 tons register. A few of large size range from 130 to 170 tons register, but the average tug is of about 80 tons, and is about 90 feet long, 18 feet wide on the beam, and 9½ feet deep in the hold. One of 170 tons would be 120 feet long, 22 feet beam, and 12 feet deep in the hold. The hulls of the tugs are sharp and deep, but not long, and float at about 8 feet draught, drawing a foot or two more aft than forward. Those that go out into rough water are given a good deal of sheer forward. The stems are perpendicular; the sterns are round and overhang from 6 to 10 feet. Although these little vessels sit low in the water, the deck being not more than 2 or 3 feet higher than the load-line, the bulwarks are always low. A house covers the machinery, which is placed amidships, and the pilot-house is either at the front of this cabin or on top of it at the forward end. Strong towing bitts are placed forward and aft of the house. A tug is simply framed and easily built, and it is a favorite boat for a rising master carpenter to undertake as his first effort at ship-building.

It has already been stated that it was the dream of Fitch, Fulton, Stevens, and other pioneers to cross the ocean with vessels propelled wholly by steam; they looked at the matter from the point of view of engineers and enthusiasts. While steam vessels were developing a speed of only 5 or 6 miles an hour the owners of deep-sea tonnage saw no advantage in steam except as a means of driving the vessel onward in calms or of enabling it to hold its course in protracted storms. In 1819 there was on the stocks in the yard of Crockett & Fickett, at New York, a staunch little ship of 380 tons, originally intended to run from that city to Savannah as a packet. Before her completion she was bought by a company, who finished her as a full-rigged ship and then put into her between decks a horizontal engine of 90 horse-power, with boilers in the hold, and fitted her with side paddle-wheels, unhoused, to make the crossing of the ocean. In May, 1819, Captain Moses Rogers took this ship to Savannah, and on the 26th of the month he set sail from that port for Liverpool, crossing the ocean in 25 days, during 18 of which she was under steam. The time made was not remarkable, but she was the first steam vessel to cross the Atlantic. In the summer she again set sail, and went around Scotland to the Baltic and to Cronstadt, where she anchored September 9. An effort was made to sell her in Sweden and then in Russia, but it was not successful. The king of Sweden offered $100,000, payable in hemp and iron, delivered at New York, but the offer was refused. The Savannah left October 6 for home, arriving at Savannah November 30. She made two voyages to Europe, and once went to Turkey, and excited much interest everywhere. The Savannah was naturally a slow sailer, and this probably was the cause of her failure as a steam vessel. After her second voyage her machinery was taken out, and the vessel ran as a coasting packet to Savannah for several years. Over $50,000 was lost in her career as a steam vessel, and she was finally wrecked on Long Island. This primitive experiment advertised to the world the enterprise and progressive spirit of American ship-builders; it startled the people of England into a determined development of their system of steam navigation. In 1823 English companies were formed with a view to establishing lines of steam vessels to the Mediterranean, with connections to India. In 1825 there was great excitement in England on the subject, and it is on record that 45 companies were formed in that year in Liverpool alone to trade with steam packets to every part of the world. Most of these projects were bubbles, which burst almost as soon as they were set afloat, but some of them were the germs of the later grand enterprise and success of the English people in steam navigation. The first steamboat was sent to India in the latter part of 1825, and others soon followed. Regular lines were established to France, Spain, and the Mediterranean, then to India and the West Indies, and finally, in 1839, to America. By 1857 there were regularly employed in the British steam mail service, under pay from the government, 121 large vessels, registering 140,000 tons, carrying 8,140 men as officers and crews, and receiving $5,335,000 a year as compensation for carrying the mails, while in her whole merchant service there were 1,670 steam vessels, registering 666,000 tons. Besides the liberal subsidies which were paid, the British government aided in the development of steam by ordering the construction of a multitude of war vessels—a policy which enabled the builders of machinery and vessels to prepare an expensive plant and train up a large force of competent engineers and mechanics. This was an advantage, as it created the facilities for building the heaviest class of steam shipping and solved many problems in regard to propelling power with which Americans afterward had to contend.

While England was pushing out to all parts of the world America was developing her river and lake boats. After the opening of the Erie canal the Hudson became the scene of the busiest internal traffic then ever seen. The West, which at the beginning of the century had been a trackless wilderness, was filling up with people. Trade was springing up rapidly on the lakes and on the western rivers, and a general increase in the size and the number of steamboats and lake propellers took place. On the lakes, where there was depth of water, the boats increased in all their dimensions; but on the rivers, where they could not venture on more than 6 to 8 feet draught, they were limited to extending the length and breadth. It is hardly necessary to follow the successive steps by which the river steamers attained the extraordinary dimensions which have been given them in the last 20 years. Suffice it to say, that the spirit of rivalry led to the production of vessel after vessel constructed to surpass everything which had preceded it in the power of its engines, the fleetness of its trips, the size and magnificence of the palace built upon its decks for the accommodation of passengers, and in its capacity for carrying deck-loads of freight. When the New World was finished for the Hudson river it was the longest and fastest vessel in the world, being 380 feet from stem to stern. The hull was 50 feet wide, the entire width over the wheels was 85 feet, and the wheel was 45 feet in diameter. The hog-frame of this boat rose 25 feet above the deck, and a row of masts from 40 to 50 feet in length, heeling on the keelson, capped with iron and rigged with iron rods or shrouds extending to the sides and ends of the boat, aided to impart rigidity to the light and shallow hull. Several strong longitudinal keelsons were put in to add to her strength and keep her broad, flat floor in shape. Her cabins were of immense size, and few hotels at that day could accommodate so many travelers. There were 347 state-rooms and 600 berths. The cabins contained elegant parlors, sumptuously decorated with carved work and gilding, rich carpets, and costly furniture. There was also a large dining-room for the entertainment of guests. Her speed was 20 miles an hour. Large as was this remarkable vessel, her length has since been eclipsed by the St. John, built for the same river in the year 1864, which was 407 feet from stem to stern. Her register dimensions were: Length, 393 feet; beam, 51 feet; depth of hold, $10\frac{8}{12}$ feet; gross tonnage, 2,645. She was built at Greenpoint. Nothing had been built since the historic galley of Ptolemy Philopater that approached her, that boat having been her superior in length by 13 feet, and the expensive steamers of the transoceanic service only now exceed her length. In speed these Hudson river boats have never been beaten. The Daniel Drew, the Mary Powell, and others have made from 25 to 28 miles an hour, and sustained that speed over long stretches of the river.

The steamboats of New York city have been admired by the builders of the whole world for the excellence of their construction. The cabins have been the most costly part of these vessels, owing to their size and the luxury of the joiner work, the carving, gilding, decoration, and furnishing. Nevertheless, the hulls have displayed the greatest ingenuity. Light, strong, and durable, they have never been excelled in the qualities that make them remarkable. They are modeled flat on the floor amidships to secure small draught, and are given long, sharp bows and long, narrow runs to secure speed. The form of the model entails weakness; but builders have found a way to give the boats the slender scantling that preserves their light draught, and yet to make them strong enough to withstand the action of powerful marine engines. Excellence of framing, thoroughness of fastening, and the use of none but the very best materials secure this result. A description of the scantling of two representative New York boats is here given:

A HUDSON RIVER BOAT.

The City of Troy, built by John Englis at Greenpoint (Brooklyn) for the passenger traffic of the river. Keel, 280 feet long; beam, 38 feet; depth from top of floor timbers to top of beam amidships, 10 feet. Side-wheel boat, with walking-beam condensing engine.

Keel.—White oak, 8 by 16 inches, with 8-foot scarfs, fastened with ⅞-inch screw bolts.

Stem.—Perpendicular; white oak, 10 by 15 inches. Apron, same size.

Stern-post.—White oak, 12 by 15 inches at the keel, 12 by 12 at the head, fastened to the keel by composition dovetail plates. The stern square, above water.

Deadwood.—Yellow pine, at bow and stern.

Frames.—White oak amidships; white oak and chestnut at the ends of the boat; top timbers, oak, chestnut, and hackmatack; double frames, the timbers each 5 by 16 inches over the keel, molded 5½ inches at the deck, with true diminish between. Spacing, 26 inches under the engines, 28 inches forward and aft. Frame timbers thoroughly fastened with 4-foot laps.

Keelsons.—Main, yellow pine, 12 by 20 inches; side, three each side of the main keelson, yellow pine, 10 by 20 inches, coming together at the bow and stern. Two ⅞-inch bolts, clinched, in each frame. Engine keelsons, yellow pine, with screw bolts through each timber.

Ceiling.—Bilge, yellow pine, six strakes, 5 by 8 inches, bolted edgewise every 4 feet and square-fastened to frames. Clamps, yellow pine, two strakes, 4 by 12 inches, 8 foot scarfs, 2 bolts and 2 screw-bolts in each frame. Yellow pine braces, 4 by 8 inches between clamps and bilge strakes, crossing at 45°, strongly fastened and keyed. Flooring, light stuff.

Beams.—White pine, 6 by 6 inches, one to each frame. Wheel beams 14 by 14 inches, molded 10 inches at the gunwales, 8 inches at the edge of the guards. Every other beam under the boilers 10 by 12 inches, molded 8 inches at the gunwales, 6 inches at the guards. Beams supported by light stanchions on the keelsons. The beam ends secured by knees; 8-inch knees on the main beams.

Decking.—White pine, 2½ by 5 inches.

Planking.—White oak, except the strings; two strakes 4 by 12 inches, yellow pine; all the rest oak, 3 inches thick; first six strakes under strings 6 inches wide, then to lower turn of bilge 8 inches wide. Fastening to 6-foot water-line, two 6-inch composition spikes and two 1½-inch locust treenails, the latter driven through and wedged; above the 6-foot line, galvanized iron spikes and treenails. The butts bolted.

Plank-sheer.—White oak, 3½ by 5 inches. Rail 3 feet from deck, yellow pine 3 by 6½ inches.

Hog-frame.—White pine; the chord about 12 by 14 inches, and the heels of the braces resting on oak chocks (or shoes), placed on the edge of the hull and securely fastened to the frames. Suspension rods from the chord to the frames and cross rods.

Gallows frame.—Yellow pine, according to the designs of the engineers.

Masts.—Six in number, 55 feet long, heeling on the main keelson, diameter 15 inches, and of white pine, capped with iron and fitted with iron rods, with turnbuckles, as follows: The two after masts, two 1½-inch rods to the after quarter of the boat and two 2-inch rods on each side to support the guards; the one next forward, two rods to the engine keelsons and two on each side to the guards, all three connected with a 1½-inch rod. Forward mast, 1½-inch rod to the bow, secured by a strap to the deadwood, two 1½-inch rods each side to the guards; second mast, two 1½ inch rods each side to the guards; third mast, two 1½-inch rods each side to the guards, and two of the same size to the engine keelsons.

Materials.—All first class, free from check, spot, or blemish, and the hull thoroughly calked, pitched, scraped, and painted.

Miscellaneous.—Wheel-houses, guards, cabins, etc., as usual.

SIDE-WHEELER FOR LONG ISLAND SOUND.

The Old Colony, for the Newport line, built by John Englis in 1864. Length from forward side of stem to after side of stern-post, 310 feet; beam, molded, 42 feet; hold, from floor timbers to under side of deck, 14 feet.

Keel.—White oak, in 45-foot lengths, with 7½-foot hook scarfs, the scarfs fastened with ⅞-inch composition bolts, clinched.

Stem.—White oak, natural crook, 10 by 14 inches, extending 12 feet above deck. Apron, 10 by 12 inches.

Stern-post.—White oak, 14 by 14 inches, with a large inner stern-post, kneed and thoroughly bolted. The stern square, above water.

Deadwood.—Oak and hackmatack, bolted with ⅞-inch bolts.

Frames.—Double, spaced 24 inches, white oak; timbers 8 by 17 inches under the engines, etc., 7 by 17 forward and aft. Molding diminishes in a true taper to 6 inches at the gunwales. Futtocks, white oak and chestnut, sided 7 inches. Top timbers, locust, chestnut, and hackmatack, sided 6 inches. Entire space between the floors the whole length of the vessel filled in with white pine to 17 inches above the base line.

Keelsons.—Main, white oak, 14 by 24 inches, lower tier fastened with one 1-inch composition bolt clinched on a ring under the keel and one bolt driven to within two inches of the bottom of the keel in each frame; upper tiers of main keelson, square-fastened. Sister keelsons, white pine, bolted transversely every 5 feet with 1-inch iron, and vertically to each frame with ⅞-inch composition. Side keelsons, 3 each side of the main keelson, same height as latter. Keelsons all tied with cross-beams of oak, 10 by 12 inches, every 20 feet jogged over each keelson and strongly kneed to the sides of the boat. On each side of engine bed there are similar cross-beams kneed to the sides of the boat. Outboard tier of keelsons placed over the floor heads. The keelsons converge at the bow and stern.

Breast-hooks.—Two forward and two aft.

Ceiling.—Bilge strakes, 5 in number, 7 by 12 inches, white oak, square-fastened with 1½-inch bolts and locust treenails. Ceiling, up to clamps, 5-inch white pine. Clamps, 3 strakes, 6 by 10 inches each, scarfed, keyed, bolted to frames, and bolted edgewise every four feet.

Beams.—White pine, 7 by 8 inches. Wheel beams, 16 by 20 inches; under the boilers, 12 by 14 inches. A beam on every frame. Knees under every beam alternately in and out, and where not kneed on the outside the beam is braced with an oak or locust brace. Wheel and boiler beams kneed inside and out.

Iron straps.—The hull is strapped diagonally on the inside of the frames with two sets of iron bands, 4 inches wide, ⅝-inch thick, crossing each other, and connecting at the top with a longitudinal band, 6 inches wide, ⅝-inch thick, running clear around the boat close under the wheel beams. The straps are hot riveted to each other and the longitudinal chord; two blunt bolts into each frame. One set of straps is let into the frames, and the ceiling notches over the other.

Decking.—White pine, 3½ by 5 inches.

Planking.—Garboards, 5 and 4 inches; bottom plank out to bilge, 3½ inches; all the rest 4 inches, except that the wales, 3 strakes, are 6 inches thick and 12 inches wide. Wales jogged 1 inch over frames. All white oak, square-fastened with composition spikes and locust treenails to the 11-foot water-line, with iron spikes and treenails above. Butt bolted with ⅞-inch metal.

Bulkheads.—Four, water-tight.

Suspension frame.—White pine and oak, with cross rods, vertical rods, and straps, to hold and secure the hull in the best possible manner.

Masts.—Five in number, with iron rods and turnbuckles to the keelsons and guards.

Model.—The floor almost flat amidships; the bow sharp, but shorter than in river boats.

Miscellaneous.—Wheel-houses, guards, cabins, etc., as in eastern passenger steamboats. Engines, walking-beam, low pressure, condensing.

The engines of the eastern boats have always been worked at low pressure. In principle they are the same as the first one brought from England by Fulton in 1806, except that the steam is used expansively. Having little room in the hull to stow away the machinery, and perceiving no advantage in changing the form of the engine in order to make it more compact and get it all below deck (a matter of importance in ocean vessels), the eastern river builders have retained the old idea of a low-pressure condensing engine with a long walking-beam placed aloft, the steam working expansively and the stroke of the piston being long and rapid. The pressure in the boilers has been on an average about 15 pounds per square inch, seldom going higher than 30, and it has often been the complaint of the builders of hulls that more speed might have been obtained if the boats could only have carried more steam. Low pressure was found to be more economical in fuel, and has been preferred. The stroke in large eastern boats has been about 10 feet, the piston traveling from 300 to 500 feet per minute and the machinery smooth and free from vibration. In the Mississippi River boats a long and slower stroke has been preferred, and high pressure without condensation has been the rule.

The paddle-shaft in eastern boats has been variously placed from one-third to one-half the boat's length from the bow, but in the Mississippi River side-wheel boats it is about the middle of its length.

On the Mississippi river the paddle-wheel has been shifted from its place on the side of the hull to the stern in all vessels built for towing purposes and in many built for freight and passengers. This was necessary to enable large boats to pass safely through the narrow canal at Louisville; but it was also the result of experience with both classes of boats, which demonstrated clearly the greater handiness of stern-wheelers for towing loaded barges and for navigating crooked channels and swift currents.

Steamboats for trips along the coast outside of the rivers and sounds were built as early as 1832, and in the course of 15 years steam vessels were plying between all the principal ports on the Atlantic and Gulf coasts. At first these vessels were all side-wheelers. They had deep hulls, and were sharp on the bottom like sailing ships, while the bows and sterns were not much sharper. The engines were the same in principle as those of the river boats, except that the walking-beam was shifted from its place aloft to a position near the bottom of the vessel, by the side of the steam-cylinder, which gave it the name of "side lever". Other changes were made with a view of bringing the weight of the machinery nearer to the bottom of the hull than in the river boats; but it must be said that, on the whole, less attention was paid in America to making the engines compact and stowing them away in the hold than in the vessels of England. However, they were good engines, securing a speed of from 10 to 12 miles per hour with a comparatively small consumption of coal. The builders of these vessels at New York were fortunate enough to attract the notice of the representatives of foreign powers in this country, and the speed and strength of their coasting steamers brought a large number of orders from Europe for steam frigates and men-of-war. The Kamschatka, built in 1838 for Russia by William H. Brown, under a contract with R. & G. L. Schuyler, was one of these ships, and was a sharp and fast frigate. Her register dimensions were: Length, 227½ feet; beam on main deck, 45½ feet; beam over all, 66 feet; depth from main deck, 24½ feet; tonnage, 2,282. After 1845 there was a change in the forms of hulls, and in order to secure the light draught needed for boats plying to southern harbors a flat bottom was adopted, with the sides amidship rising straight from the bilge to the main rail. The United States, built in 1847 by William H. Webb for C. H. Marshall & Co. for a New Orleans packet, was one of the first vessels of this class, and was intended to beat any other Atlantic vessel in speed. Departing from the standard type, Mr. Webb gave her a floor with ½ inch of dead rise to the foot, about 2½°, the water-lines of the bow and stern being slightly concave. Her register dimensions were: Length, 256 feet; beam, 40 feet; depth, 30½ feet; tonnage, 1,857; length from taffrail to head, 277 feet. For 50 feet at each end her frame, deadwood, and keelsons were of live oak, locust, and cedar, the frames being spaced 32 inches at the extreme ends, while amidships the lower timbers were of southern white oak, spaced 25 inches, the top timbers being live oak, locust, and cedar. She had five rows of yellow-pine keelsons amidships, 3 feet deep and 4 rows 16 inches deep, the bilge strakes were 12 inches square, and throughout she was of similarly heavy build, being a strong, heavy boat. The United States was sold to the German confederation for war purposes, but in later years went into the merchant service, where she was noted for the large cargo she carried on a light draught of water. Her launching draught was 7 feet 1 inch forward and 8 feet 4 inches aft, with a 12-inch keel. The large steamers which were demanded immediately afterward by the California excitement, with their successors, were all of this general type, and had full, flat floors, straight sides, and sharp bows and runs. This model has governed the form of American deep-sea steamers to the present day, the only departure having been to lengthen the bow into a longer, sharper wedge; a change made practicable when they began to build hulls of iron.

On the 3d of March, 1847, Congress authorized the Secretary of the Navy to make contracts for mail-steamship service once in two months, or oftener, from New York to Chagres, on the isthmus of Panama, and from Panama to Astoria, in Oregon, touching at Monterey, San Diego, and San Francisco, the object being to aid in populating the Pacific coast and to shorten the 120-day voyage around cape Horn to 30 days. George Law secured the contract for the Atlantic branch of the service, and called his company the United States Mail, and Howland & Aspinwall, of New York, secured the other contract, and called their company the Pacific Mail. For the Pacific service three steamers were built in 1847 and 1848 at a cost of $600,000: the California and the Panama, of 1,058 and 1,087 tons respectively, 200 feet long from the plank on the stem to the after side of the stern-post, 33½ feet beam, and 22 feet hold, by William H. Webb, and the Oregon, of 1,099 tons, by Smith & Dimon. For the Law line three steamers were also built, namely: the Georgia, 2,727 tons, 255 feet long, 49 feet beam, and 25½ feet depth of hold; the Illinois, 2,123 tons, 267¾ feet long on deck, 40¼ feet beam, and 31 feet hold; and the Ohio, 2,432 tons, 248 feet long, 45½ feet beam, and 24½ feet depth of hold. These were all wooden paddle-wheel steamers with from 33- to 36-foot wheels, capable of carrying several hundred passengers and about 1,500 tons of freight each. The California was the first afloat, but in the latter part of 1848 the three Pacific Mail vessels were sent off one after the other to begin the service on the Pacific coast. A railway was meanwhile building across the Isthmus. It was while the three ships were *en route* from New York that the news of the discovery of gold arrived in the East; and when the California touched at the Isthmus on the way to the north her captain was astonished to find an excited crowd of thousands of people awaiting her arrival, anxious to reach San Francisco at the earliest possible moment. Each one of the three ships went northward crowded to its fullest capacity.

It has already been explained what an impetus the California excitement gave to the building of sailing vessels, developing the great clippers; it also stimulated the construction of large steamers in an equally wonderful manner. It came at a time when the mail, passenger, and express traffic on our coasts was small; when only a few steam vessels were building for a few modest coasting lines plying between the Atlantic and Gulf ports, and before they had attained any considerable size. As soon as gold was discovered in California a trade sprang into existence in one year of greater magnitude than would have been reached in twenty years of ordinary growth on the Pacific coast, and the steam fleet engaged in that trade needed to be enlarged immediately. Steamer after steamer was added, and in the course of the following ten years 29 fine vessels of 38,000 tons register had been built for the Law and the Howland & Aspinwall lines alone, at a cost of about $8,300,000. It is estimated that in the first ten years these steamers had carried 175,000 persons to California and brought back $200,000,000 in gold. The trade finally grew beyond the capacity of the 1,100- and 1,800-ton vessels, and the companies daringly built of wood up to 2,600 tons, and then in 1861 up to 3,315 tons. The Golden City, of 3,373 tons, was built in 1864, being a steamer 343 feet long to the after side of the stern-post, 45 feet beam, and 29¾ feet hold. The California and Aspinwall steamers were all built at New York; and as the majority of all the Atlantic coasting steamers were also built there, besides vast numbers of sailing vessels, it made New York the great center of vessel-building in the United States. In the ten or twelve busy years before the war 10,000 men went to work in the ship-yards of that city every day, and Webb and one or two others had each more than 1,000 men. The row of ship-yards on the East River side of New York city had at the same time 20 or 30 great vessels on the stocks in different stages of construction. Unlike the sailing-vessel industry, which was distributed along the coast, the production of steamers was concentrated at a few points in the large cities, where there were engine-shops and banks with heavy capital, of which New York, Philadelphia, Boston, and Baltimore were the principal. The work of the New York builders gave them great reputation, and they were able to obtain large and profitable orders for war steamers from Russia, France, Italy, Portugal, Turkey, and other foreign governments, bringing millions of money to that city, among them the propeller frigate General Admiral, of 4,500 tons, 325 feet long, 55 feet beam, 34 feet hold; the iron-clad frigates Re d'Italia and Re Don Luigi de Portugallo, each of 3,700 tons, and the iron-clad ram Dunderberg, of 5,090 tons, 380 feet long, $72\frac{5}{6}$ feet beam, and $22\frac{7}{12}$ feet hold, with a 7¾-foot casemate. Taking the whole period from 1830 to 1861, there were built in the four principal cities of the Atlantic coast about 80 sea-going steamers for the coasting and California trades and on foreign orders, aggregating 120,000 tons in register and costing about $29,000,000. Five-sixths of this tonnage was produced at New York city.

The screw-propeller made its first appearance in the coasting trade at New York in 1841, the Clarion, of about 250 tons, being built in that year for service between New York and Havana. This little vessel was the pioneer of the present splendid fleet of screw-steamers in the coasting trade, and was driven by a 6⅓-foot Ericsson wheel. Philadelphia quickly followed the example of New York, and, in fact, was much more energetic in adopting screw-propulsion. In 1842 six screw-steamers were built at Philadelphia, two of 80 tons each for trading to Baltimore, and four of 200 tons each to run to Albany and Hartford, with 6½- and 6-foot wheels, respectively, all of the Ericsson patent. Other vessels of the same class followed from time to time. After 1850 the larger class of coasting steamers began to adopt the screw, and paddle-wheels were gradually superseded; and since 1865 few paddle-wheel vessels have been built for the coasting trade, except for that part of it which flows through Long Island sound, and in the coasting lines whose service is entirely outside of the bays and sounds the paddle-wheel has now, in 1882, almost entirely disappeared. As vessels increased in size the screw increased in diameter to 8 feet, then to 10 feet, and it is now 14 and 16 feet. The Ericsson patent was in the ascendancy in the earlier years; but engineers were never quite satisfied with it. Woodcroft, in England, and, following him, various American inventors, including Loper, at Philadelphia, had experimented with screws based on the principle of an expanding pitch. In the original propeller the blades were set at right angles to the axis, and had the twist of the real Archimedean screw, while in the Woodcroft and later propellers the blades took somewhat the form of the three- and four-leaved clover, and had a second twist in them, the pitch expanding from the axis to the periphery. The blade has become elongated in the course of the experiments of the last twenty years, and its form has changed from time to time, but the general principle of an expanding pitch has been retained. This type of propeller, usually with three or four blades, but sometimes with two, is now in universal use in America, except on the Erie canal. The shaft for the screw is carried out directly through the deadwood aft and the stern-post, and the pistons of the engines, as a rule, act directly on cranks connected with the shaft. The old system of cog gearing on the shaft has been superseded, except in a few types of small vessels; but in tugs and large steamers, as a rule, the piston acts directly on the shaft. The screw continues to grow into popularity every year, and is gradually being introduced into all branches of steamboat service. On the Hudson it is now employed in many ferry-boats and river freighting steamers, and the ferry-boats at Detroit also are now screw vessels.

In 1838 attention was called to transoceanic navigation a second time by the enterprise of some merchants of England. Great Britain was meeting with much success in her commercial schemes, and a great advance had been made in the construction of hulls and machinery suited to steam navigation over the open sea. The speed of steamers had been increased to 10 miles per hour, and it was then believed that, by employing the best resources of the naval art, steamers could be produced which would successfully contest for the supremacy in trade to the American continent. The most profitable traffic of that day was the carrying of mails, express freight, and passengers between England and the United States, which was almost entirely in American hands. The average time of the packets was from 19 to 21 days from New York to Liverpool and 20 to 26 days back. The Sirius, of 700 tons, was built at Bristol, and the Great Western, of 1,340 tons, at London, both fast and handsome paddle-wheel steamers, and were dispatched to New York from Cork and Bristol in 1838, their voyages being successfully completed in 17½ and 15 days, respectively. The time made going home to Falmouth and Bristol was 17 and 14 days, respectively. This experiment gave great satisfaction in London, securing favorable influence from the government, and the Cunard line of steamers was, in 1840, the product of the agitation on that subject. Several companies were formed, but the plans of Samuel Cunard were the first that received the approval of the government. Cunard built four paddle-wheel steamers of about 1,140 tons each, and he was authorized to carry the mails to Halifax and Boston for a yearly compensation of £80,000. In a few years the line was extended to New York, with a yearly compensation of £145,000, afterward increased to £173,000 a year. The plans of Cunard were carried out in such a manner that they met the expectations of the owners of the line and of the English government perfectly, and seldom has a grand commercial scheme been crowned with such triumphant success. The Cunarders and the various other steamers sent out to trade to New York and Boston got the mails and passengers at once and gathered up all the best of the other business to Liverpool in the course of a very few years; and while sailing packets persevered in competition with them so far as the heavy freight and emigrant traffic was concerned, yet the American lines were compelled to send off their ships, one after another, into other departments of trade, and in ten years from 1838 it had only become a question of time when they should all be withdrawn. Although we had 20,000 vessels at sea, we were compelled to depend entirely on British steamers running to every part of the globe for the transmission of the letters and dispatches of our merchants and ship-owners.

The first large American ocean steamer seems to have been the ship Massachusetts, of 751 tons, owned in Boston, which was sent out in 1844, with steam machinery and screw-propeller to be used as auxiliary power.

In 1847 two American steamers built at New York for Edward Mills by Westervelt & Mackay began the competition from New York to Europe with the British line. Mr. Mills had the encouragement of Congress in this matter. In 1845 the postmaster-general was authorized to contract with him for 20 trips a year to Europe for the sum of $400,000, the theory on which this grant was made being that America could only hold her position on the sea by creating a fleet of steamers. This class of vessels was expensive to build and run, and at the rates of freight and fares then current each trip would net the ships a loss of from $15,000 to $25,000. England was paying her steamers a sum which would make up their losses and give them a profit on their investments, and unless America would do the same thing she would lose the carrying trade. Congress was almost unanimous on this subject, and the contract with Mr. Mills was made, a portion of the money due him on his first year's service being advanced to aid in building the ships. Their destination on the other side was Bremen, and they were to sail once a month in winter and twice a month in summer. The ships were constructed like large sailing packets, but longer, and were simply long square-sterned three-deckers, with one white streak along the sides, painted black at intervals, for ports. The paddle-wheels were placed on the sides in the middle of length, the funnel being slightly forward of them. They were bark-rigged, had a full complement of spars and sails, and were stoutly built, in accordance with the rules then prevalent for sailing ships, but with additional weight and fastenings, in order to withstand the action of the engines. Their specifications were as follows:

	Washington.	Hermann.
Length on main deck	230 feet	241 feet.
Length on spar deck	236 feet	235 feet.
Breadth of beam	39 feet	40 feet.
Depth of hold	31 feet	31 feet.
Average draught of water	19½ feet	19½ feet.
Custom-house tonnage	1,640 tons	1,734 tons.
Engines	Two side-lever	Two side-lever.
Diameter of cylinders	6 feet	6 feet.
Length of stroke	10 feet	10 feet.
Diameter of paddle-wheels	34⅜ feet	36 feet.
Length of paddles	7½ feet	8 feet.
Depth of paddles originally	3½ feet	3 feet.
Depth of paddles in 1851		2⅛ feet.
Depth of paddles in 1852	2⅜ feet	2 feet.
Number of paddles in each wheel	28	28.
Average dip of paddles	6⅓ feet	
Number of revolutions per minute	11	11 and 12.
Pressure of steam	14 pounds	12 pounds.
Cut-off	⅓ stroke	⅓ stroke at first. 3½ feet after change.
Boilers	2 iron flue, side by side	2 iron flue, side by side.
Boilers changed in 1851		4 tubular.
Height of chimney above grate	75 feet	75 feet.
Consumption of soft coal per hour	3,360 pounds	3,920 before the change. 3,546 after change.
Average speed per hour	11 knots	
Trips from New York to Bremen made in	From 12⅓ to 16 days	From 13⅓ to 17 days.
Trips from Bremen to New York made in	From 11$\frac{22}{24}$ to 17 days	From 13$\frac{15}{24}$ to 19⅓ days.

The original paddle-wheels of the Washington were 37⅔ feet, but they were changed after the first voyage on account of their excessive dip. The paddles being too wide at first in both ships, and the boilers not having capacity enough, new furnaces were added, and various other expensive alterations were made. The ships were excellent sea boats, and as good carriers as ocean steamers were in that day of bulky machinery and large coal consumption; but they never showed great speed, being beaten regularly on their voyages two or three days by the Cunard steamers.

In 1850 the Franklin and the Humboldt were built by Westervelt & Mackay at New York. They were intended for the Bremen line, but were placed by Messrs. Fox & Livingston in the trade to Havre. The details of construction were:

	Franklin.	Humboldt.
Length on deck	263 feet	292 feet.
Breadth of beam	41⅝ feet	40 feet.
Depth of hold	26 feet	27 feet.
Average draught	18 feet	19½ feet.
Tonnage	2,184	2,181 feet.
Engines	2 side lever	2 side lever.
Cylinders, diameter	7 feet 9 inches	7 feet 11 inches.
Cylinders, stroke	8 feet	9 feet.
Paddle-wheels, diameter	32⅓ feet	35 feet.
Length of paddles	11½ feet	12 feet.
Depth of paddles	1 foot 8 inches	2 feet.
Average dip of paddles	6½ feet	8¼ feet.
Number of paddles in each wheel	28	36.
Boilers	4 iron flue, back to back	4 iron flue, back to back.
Boilers—length, height, and breadth		27 feet, 11 feet, 14 feet.
Height of chimney above grate	63 feet	65 feet.
Consumption of soft coal per hour	6,150 pounds	6,500 pounds.
Average pressure of steam	15 pounds	15 pounds.
Number of revolutions	13	14.
Cut-off at	3 feet	4 feet.

The average run of these ships from New York to Cowes was 12$\frac{17}{24}$ days, and on the return 12$\frac{22}{24}$ days.

Simultaneously with these two projects was conceived the idea of a line to Liverpool. Never beaten in the size, speed, and beauty of their clippers and sailing packets, the ship-owners and capitalists of New York had faith that they could go to the front with steamers also if the government would put them on an equal footing with the English shipping men, as it had ever since independence in regard to other maritime matters. The Liverpool line originated with Edward K. Collins, a man of exceptional enthusiasm and energy of character, who was successful in winning the support of some of the strongest men in New York city for his plan. Mr. Collins went into the matter with the express purpose of producing a line of steamers which would excel the Cunarders in every desirable point and would re-establish the commercial superiority of the United States. In aiding the project Congress was governed by the same idea, and also by a secondary consideration of some weight. A number of expensive steam frigates had been built for the navy, among them, in 1840 and 1841, the Mississippi and the Missouri, which had cost respectively $550,000 and $598,000. In 1843 the Missouri had taken fire at Gibraltar and was totally consumed. Congress shrunk from this expense and loss, and it was conceived that if private citizens could be encouraged to build steam vessels suitable for war purposes great sums of money would be saved to the public treasury. Under the laws of 1845 a contract was accordingly made with Mr. Collins, whereby he was to build and run four steam vessels from New York to Liverpool, making twenty trips per annum, and carrying the mails for $385,000 annual compensation. The ships were to be of 2,000 tons register, of the most powerful character, and suitable for men-of-war in case of need. The Cunarders were then of 1,140 to 1,500 tons register. Mr. Collins was resolved upon unquestioned excellence, and he forthwith prepared to build four ships of 2,800 tons register each of the best materials and workmanship and fitted with machinery of unusual power. The Arctic, of 2,856 tons, the clipper of the fleet, and the Atlantic, of 2,845 tons, were built for him in 1849 by William H. Brown, at New York, under the superintendence of George Steers, a famous builder. The Baltic, of 2,723 tons, and the Pacific, of 2,707 tons, were built by Brown & Bell, of New York. The machinery for these vessels was supplied by the Novelty and Allaire works of New York city.

In selecting a model for his fleet Mr. Collins chose some of the peculiarities of the modern swift propellers. He adopted a straight though slightly raking stem, a long, sharp, wedge-like bow, and a long, easy run. The floor was full, but with easy lines everywhere. The hulls were carried up out of water high enough to inclose the houses and cabins, and gigantic four-deck structures were produced, with a full complement of masts and spars, that loomed up long and large above every other ship in the port of New York and won the unqualified admiration of all who saw them.

The following are the details of construction of the Arctic and the Baltic: Length of keel, 277 feet; length on main deck, 282 feet; depth under spar deck, 32 feet; under main deck, 24 feet; beam, molded, 45 feet; round stern; 4 decks; 3 masts. Frame, white oak and chestnut, with tops of locust, live oak, and cedar; stanchions and timber-heads, white oak; apron, lower and main deck breast-hooks, and inner stern-posts, live oak; keel, white oak, 17 by 20 inches; frames, double, sided 24 inches, molded 21 inches over the keel; lower futtocks sided 12 inches each; all the other timbers 10 inches each. Spacing 30 inches amidships, increasing to 36 inches at bow and stern; floors filled in solid to the turn of the bilge. Ceiling, clamps, and water-way of lower decks, yellow pine; bilge streaks, five in number, 12 inches square, bolted edgewise every 4 feet; clamps of the lower deck, 8 inches; upper deck, 7 inches; all other ceiling under the main deck, 7 inches. Outside planking yellow pine, except the garboards, which were white oak, 15 inches wide and 9 inches thick, copper-bolted edgewise with 1-inch metal every 3 feet, and with two bolts through each timber; all the rest of the planking 5 to 7 inches thick and 6 to 8 inches wide to 3 feet above the main deck. Main keelson, white oak, 32 by 34 inches; side keelsons, yellow pine, except under the engines, where white oak, 22 by 42 inches, was employed; under the boilers, 22 by 27 inches. Lower and main deck beams, sided 12 to 14 inches, molded 13 inches in center, and 10 inches at the ends; spar-deck beams, $6\frac{1}{2}$ by 8 inches in the middle; beams, yellow pine, except that some white pine was used in the orlop and spar decks. Decking, white pine; orlop deck, 3 inches; lower, $3\frac{1}{2}$; main, 4; spar deck, 3 inches. Knees, white oak and hackmatack; bulwarks, 3-inch white pine. The hulls were square-fastened with two $\frac{7}{8}$-inch copper bolts and two locust treenails to 20 feet draught of water; above that galvanized iron and treenails were used. The frame was strapped with iron, crossing amidships like a lattice work, the spacing being 4 feet. The engines were two in number, large and powerful, of the side-lever type, having cylinders 95 inches in diameter, with 10 feet stroke. There were 4 tubular boilers, 22 feet long, $14\frac{1}{4}$ feet high, two 14 feet wide and two 15 feet wide. The smoke-pipe projected 45 feet above the spar deck. There were double furnaces. With 13 pounds pressure the engines had 800 horse-power. The launching draught of the Arctic aft was 10 feet. The hull weighed 1,525 gross tons; spar and top gear, 34 tons. With an ordinary cargo she drew 20 feet of water aft and about 6 inches less forward, and would carry 250 passengers and 2,000 tons of freight.

The best engineering talent of the day was consulted with regard to every point about the hulls and machinery of these four noble vessels, and in every detail they were of excellent design and workmanship and in appearance imposing. Service began with these ships in 1851.

The Cunard steamers were making the voyage from New York to Liverpool in from 10 days 6 hours to 14 days 3 hours, averaging in the year $11\frac{1}{2}$ days. From Liverpool to New York their time varied from 10 days 2 hours to 16 days 20 hours, averaging 12 days 9 hours. The Collins vessels beat this time from the start by an average

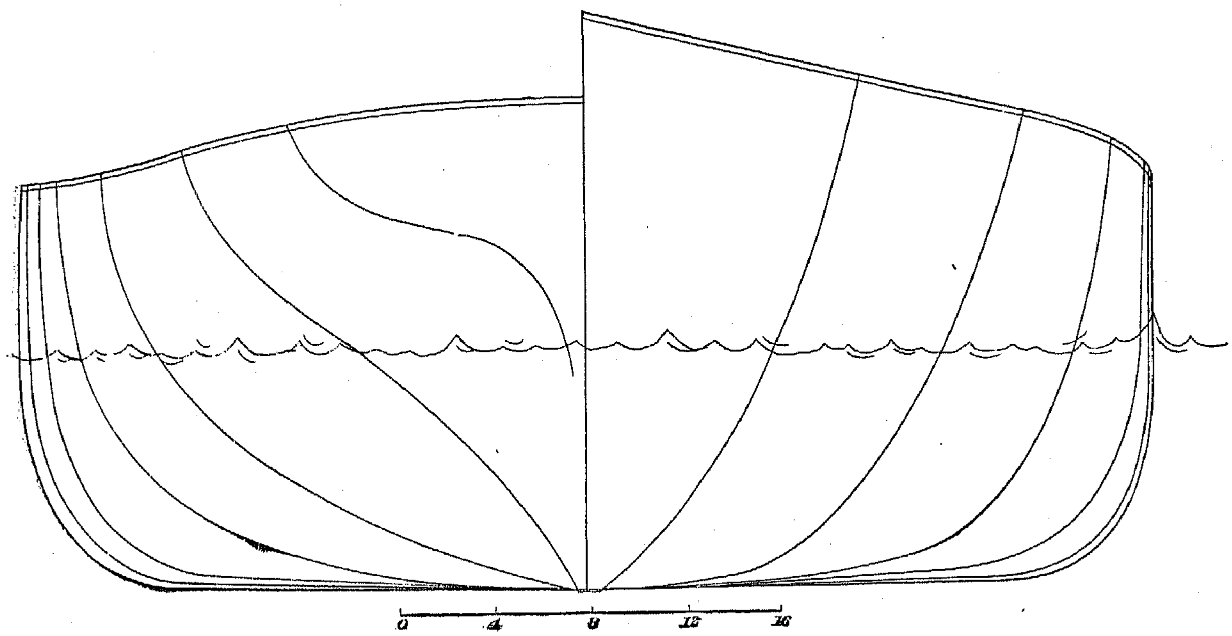


Fig. 45.—Lines of eastern river steamboat.

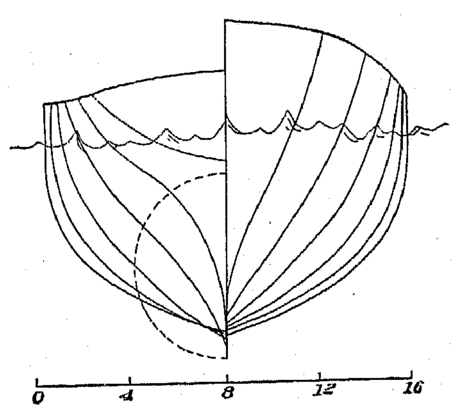


Fig. 46.—Lines of harbor tug.

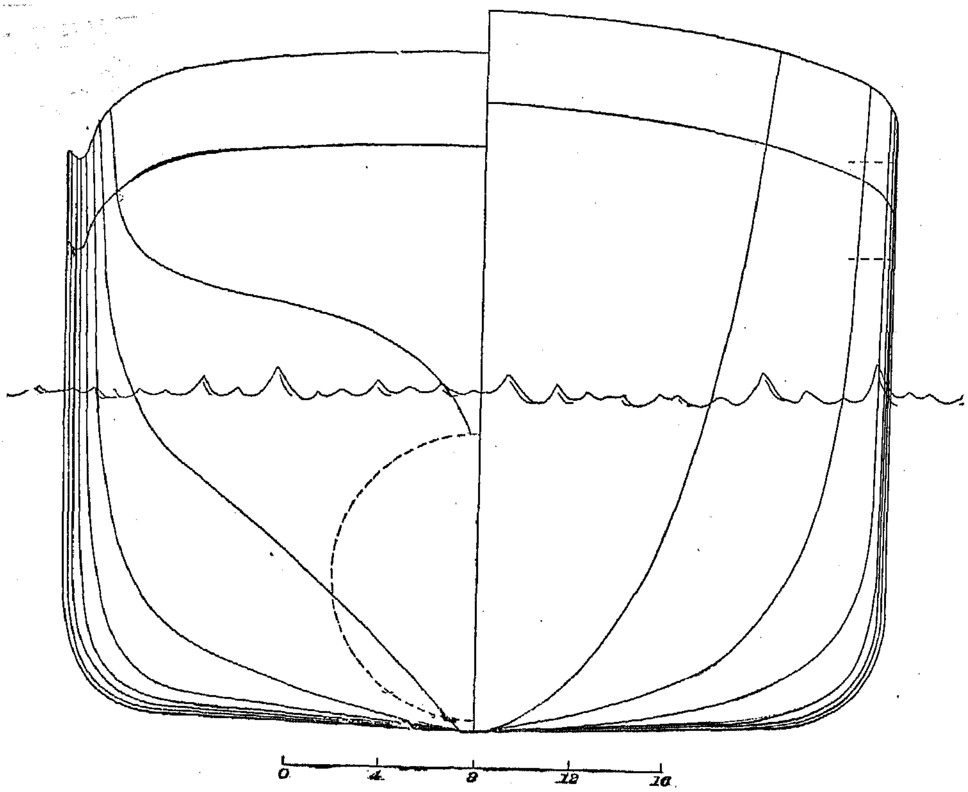


Fig. 47.—Lines of northern lakes propeller.

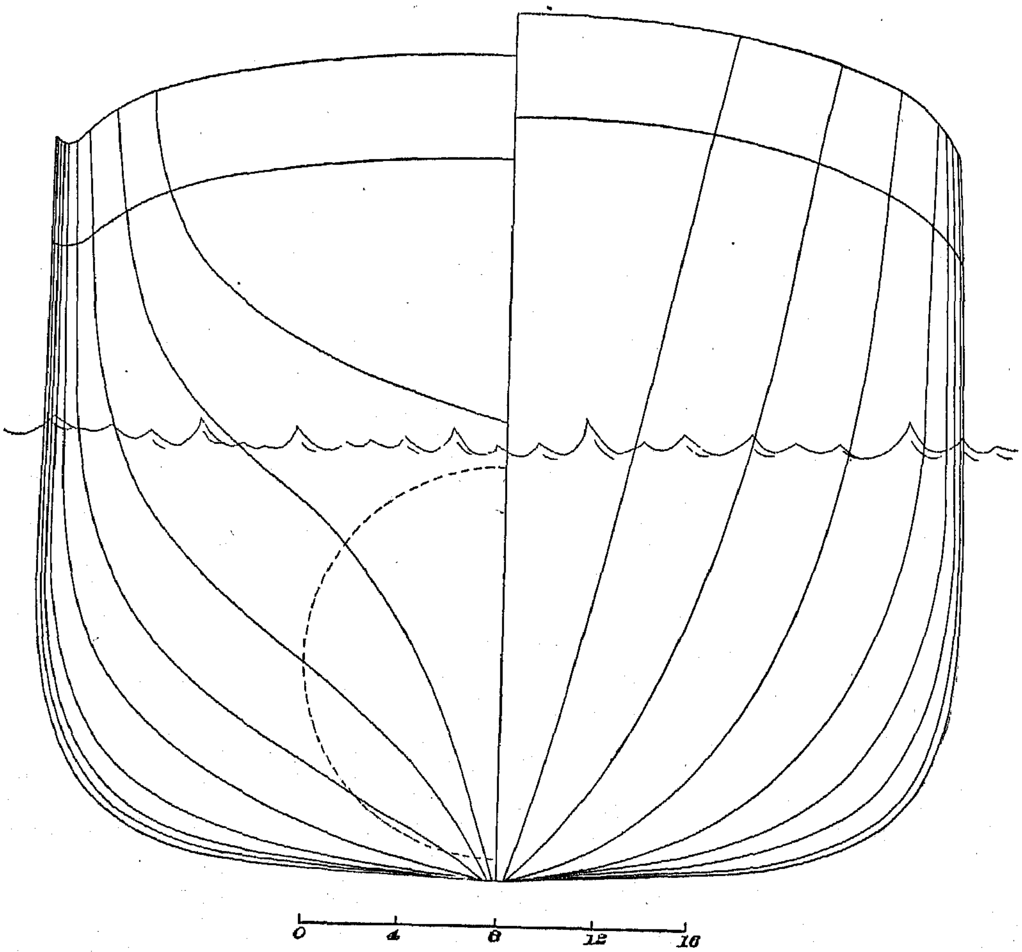


Fig. 48.—Lines of fast coasting propeller (iron).

of about one day, their voyages to Liverpool being made in from 9 days 17 hours to 12 days 9 hours, an average in a year of 10 days 21 hours; the return trip was accomplished in from 9 days 13 hours to 13 days 17 hours, the average being 11 days 3 hours. The ships had the confidence of the public, and were liberally patronized. From January to November, 1852, inclusive, for instance, they carried 4,306 passengers, as against 2,969 who went by the Cunarders. Their competition for freights brought the rates to Liverpool down from £7 10s. per ton to £4; a great public benefit, because the United States were importing enormous quantities of European manufactures and paying the cost of freighting to this country. The voyage to Europe was shortened by these ships and travel was promoted, and in eight years from the time they began the passenger traffic had increased fivefold.

The Cunard line began to build new and large steamers of greater power the moment the Collins line was undertaken. Collins' mail pay was increased to $858,000 a year, and greater speed was required of him. He fulfilled the requirement, and the company that backed him spent large sums of money in perfecting their engines and machinery and maintaining their boats in full efficiency. In 1854 the Arctic was lost at sea by a collision in a fog with the French steamer Vesta, only 45 out of the 368 people on board ever reaching land. The Pacific was lost in 1856 with all on board, numbering 186 persons, and a valuable cargo. The ship with her contents was insured for that trip for $2,000,000, and nothing was ever heard of her after leaving Liverpool, in January, 1856. Neither was built with bulkheads. Collins acted with energy in replacing the Arctic. In 1855 he built the colossal Adriatic, of 4,144 tons register, 345 feet long, 50 feet beam, and 33 feet hold, at a cost of $1,100,000. The ship cost more than was expected, owing to alterations in her machinery and her long detention in port while the changes were being made; but she was a good vessel, fast and capacious, and once in 1861 made a trip from Saint John's to Galway in the unprecedented time of 5 days 19¾ hours.

Beginning in 1853, a movement had sprung into existence for canceling Collins' subsidy. This agitation went on, until in 1856 the pay of Collins was reduced to $385,000 a year, and in 1857 it was withdrawn altogether by the refusal of the government to renew the contract; the contract with Mr. Mills also expired. Meanwhile the English people had been organizing new lines to America, and Collins and Mills could not contend with them single handed, as their round trips cost from $40,000 to $65,000 each, and ordinary receipts were from $10,000 to $16,000 less per trip. The Cunard line had a subsidy of $866,700 a year and the other English lines a generous compensation, though not so large. The odds being too great, the Collins and Mills ships were withdrawn and sold, and competition for the mail, express freight, and passenger business to the northern ports of America was deliberately abandoned to English, French, and German steamers. The war of 1861 broke out in the United States four years afterward. During and after that war the English steam companies extended their operations, and have since been gaining steadily in the trade of the whole Atlantic coast of North America. Beginning in 1856, Mr. Vanderbilt, of New York, ran a steamship bearing his name and two others to Havre for a short time, but afterward sold the vessel to the United States government. In 1866 an American company was formed in Boston, and two large oak-built wooden screw steamers, the Erie and the Ontario, were constructed at Essex and put into the business from Boston to Liverpool; but the English steamers instantly lowered their rates of freight, and after a very few voyages the two vessels had to be withdrawn.

A line was afterward started from Baltimore in connection with the Baltimore and Ohio railroad. This also had a brief existence.

The only other American steamship line to Europe was that which is still running from Philadelphia to Liverpool and has four iron propellers of American build. It was started in 1873. The ships run in connection with the Pennsylvania railroad, which owns the principal part of the stock of the company. The ships will be described in the chapter on iron-ship building.

The steam vessels of the United States were confessedly superior for transatlantic service to those of European build as much as the American sailing clippers were to their foreign rivals. Owing, however, to the artificial manner in which the steam shipping of Europe was brought into existence and maintained and the want of government compensation American owners of ocean steam tonnage were forced to withdraw from the traffic to Europe, and our builders were compelled to rely entirely on coasting trade for business.

Very few other attempts have been made to put American steamers into foreign trade. The coasting lines to the South have called at Havana in Cuba and have pushed their voyages to Mexico. Two or three attempts have been made to trade to Brazil. Commodore Garrison, of New York, ran some wooden steamers after the war from New York to Brazil for a few years with the aid of a subsidy, and John Roach ran a line of iron steamers during the years from 1878 to 1881.

The Pacific Mail has sent steamers to the Sandwich islands, Japan and China, and Australia. These ships will be more particularly referred to under the heading of iron vessels. No other attempts to run steamers in foreign trade have been made, except to Mexico and the West Indies.

As has already been seen, the steam craft of the United States were all built of wood in the earlier years. The frames were of white oak, chestnut, live oak, and locust; the planking was at first oak, but in time yellow pine came to be employed extensively at the ocean ports for the same purpose, as also for keelsons, beams, ceiling, etc. White pine has always been used for decking, houses, keelsons, and beams. On the western rivers white pine and poplar have been the light woods employed, nearly all the rest of the boat, outside and in, being of oak.

On the northern lakes the boats have been framed, planked, and ceiled with oak, beams, decking, and houses being of white pine. Of late iron has come into use extensively for hulls on the sea-coast and the northern lakes, and for many years past all the coasting steamers have been built of it; but this material is, as yet, little used on the western rivers, owing to the abundance of wood and the smoothness of the waters navigated. For the rough waters of the sea, and even for the smooth waters of deep rivers, iron is far superior to wood for steam vessels; and although its cost is high, it is now coming rapidly into use on the coast in all classes of boats, large and small. Tugs, ferry-boats, yachts, excursion steamers, Sound boats, and Hudson River boats, as well as coasting propellers, are now built indiscriminately of iron.

The localities in which steamers are now built in America, and the extent of the industry, are given below.

OCEAN COASTS.

In Maine steamboat building is limited. Small fishing steamers are constructed at Boothbay, Eastport, Portland, and Kennebunk as they are needed from time to time, and a few tugs are produced every year. Both classes of boats are propellers. Occasionally a river or coasting steamboat of the ordinary type, with side paddle-wheels and walking-beam engine, is required, and a number of small propeller launches have been made for summer travel between local points among the islands of the coast. Latterly in Bath whale-ships have been supplied with engines of small power, with a propeller wheel capable of driving the ships about 6 miles per hour. In 1882 a freighting sail ship was supplied with the same power as an experiment, for use in the latitude of equatorial calms. So far as Maine is concerned, steamers are only a small item in the product of the ship-yards.

Essex is the principal place for building steamers in Massachusetts. Wooden propellers and tugs are frequently produced in that town, chiefly on Boston account. At Boston the work in this line is now entirely confined to ferry-boats and pleasure boats.

In Rhode Island there is an establishment at Bristol, called the Herreshoff Manufacturing Company, which builds a special class of small swift propellers to serve as vidette boats and pleasure yachts. These boats are modeled, constructed, and fitted out with a view of getting the highest possible speed, while at the same time leaving room for large and comfortable cabins for the guests. Two vidette boats built for the English government were 48 feet long, 9 feet beam, and 5 feet deep from the gunwales, and were framed with oak; the planking was fastened with brass screws. The engines were of 125 horse-power, and in each case the whole boat with machinery aboard weighed only 7 tons. With a pressure of 140 pounds of steam and the propeller making 550 revolutions per minute the boats ran at a speed of $17\frac{3}{4}$ miles per hour. On their arrival in England they were each supplied with one Gatling gun, and were employed for the torpedo service. The late Herreshoff boats have been built with iron frames and wooden planking, and one of them has attained a speed of 25 miles an hour.

In model the Herreshoff boats have been varied, first one way, then another, as in regulating a watch, until the exact result has been attained at which the designer aimed. The hulls are long, low, and sharp from keel to gunwale, increasing in beam above the water. The water-lines are as sharp as practicable, and the draught of the hull forward is 2 or 3 feet less than it is aft. The hulls are built as lightly as possible, in order to obtain light draught, and the workmanship is correspondingly careful in order to obtain strength.

A description of the steam-yacht Leila (Fig. 49), built in 1878, will illustrate the Herreshoff idea. The boat is 100 feet long over all, and 95 feet 5 inches long from the forward edge of the stem to the after side of the stern-post on the water-line. Extreme breadth on deck, $15\frac{1}{3}$ feet; on the water-line, $11\frac{3}{4}$ feet; depth of hull amidships from lower edge of planking to top of deck beams, 5 feet 10 inches; draught forward, 2 feet $7\frac{1}{2}$ inches; aft, 5 feet $1\frac{1}{2}$ inches. Midship section, $54\frac{1}{2}$ feet from the forward edge of the stem. Coefficient of water-line, 62 per cent.; of midship section, 56 per cent.; displacement, 37 per cent.; dead rise, $21\frac{1}{2}°$. Angle of entrance at bow, 17°; of run, 28°. Frames, iron, $1\frac{1}{2}$ by $2\frac{1}{4}$ inches, $\frac{1}{4}$-inch thick; deck beams, 2 by $3\frac{1}{2}$ inches. Stem, oak, 6 inches thick; stern-post, oak, 7 inches thick. Planking, pitch-pine, $1\frac{1}{4}$ inches; keel, oak, 7 by 10 inches; deck plank, $1\frac{3}{16}$ inches. Bulwarks, very light, 30 inches high. The total weight of the boat, with machinery, water, and coal aboard, was $37\frac{1}{2}$ tons net. A brass propeller wheel was put in, 4 feet 7 inches in diameter, four-bladed, $9\frac{3}{4}$ inches long, with a pitch of 8 feet. The draught of water of the hull proper was so small that in order to bury the screw sufficiently the shaft was fitted very near to the top of the keel. The blades projected below the keel, which required the addition of a skag to protect the screw and support the metallic shoe underneath. The skag was $15\frac{1}{2}$ inches deep below the bottom of the keel at the stern-post and 5 feet long on the keel, being sided 7 inches. In some Herreshoff boats the skag is replaced by a bent brass arm, which is riveted to the keel and extends downward and under the screw and then up again to receive the heel of the rudder-post. The rudder was of metal, counterbalanced, the axis being placed at one-quarter the breadth from the forward edge. The engine was compound condensing, and had 2 vertical cylinders, placed side by side, one of them 9 inches in diameter, with 18 inches stroke, the other 16 inches in diameter, with 18 inches stroke. The pistons were connected with cranks on the shaft at right angles to each other. A surface condenser was employed, consisting of a single copper pipe running outside of the vessel under water around the stern-post. The boiler is a peculiarity of all the Herreshoff boats. It has a circular furnace, into which descends a double coil of continuous wrought-iron pipe $1\frac{7}{8}$ inches in diameter and $\frac{3}{16}$ of an inch thick, arranged as if it had been wrapped around two cones, one fitting beneath the other. The flames play about these coils; all the water in the boiler is in this pipe, entering at one end as water and going out at the other as steam. The advantages of this boiler are light weight, economy of fuel, quick raising of steam, and security against explosions. In the Leila the combustion was 2¼ pounds of coal per hour per horse-power. A pressure of 125 pounds was maintained in the boiler with 350 pounds of coal per hour, the speed of the boat being 14 miles an hour, and it required only from 3 to 5 minutes after starting the fire to make steam from cold water to work the engine. A small house was built upon the Leila to cover the machinery. The pilot-house was in front of it, and the cabin aft.

The invention of the safety-coil boiler has led to a wonderful multiplication of steam yachts throughout the whole of the United States within the last ten years. On all the small inland lakes, especially in New York state, where rowing and sail boats have been owned by young men for years in great numbers, the steam yacht has sprung into great popularity. The boats seldom exceed 25 feet in length, and would not be large enough to register in the custom-house, even if they were subject to it, under the laws of the United States. They are usually open boats, carry from 10 to 20 persons each, and are the popular luxury of prosperous men who live near romantic lakes. The hulls of these boats are always built entirely of wood, after the fashion of large rowing barges, and sometimes have cabins, but usually have awnings only.

The steamboat building of Connecticut now consists only of an occasional vessel at Noank, a few river boats on the Connecticut river, and a small fishing steamer now and then at South Norwalk. A large number of river boats and war vessels have been built in times past upon the Connecticut, but the industry is nearly at an end.

On the Hudson river small boats of the ordinary side-wheel pattern are built at Newburgh, Rondout, and Athens from time to time as they are needed for local traffic. Many of them are for towing only, having no houses, except simply to protect the machinery and wheels and accommodate the officers and crew. The hull is low in the water, the deck is open, and the cabin is supported aloft by a bridge between the wheel-houses. Iron hulls have latterly been made at Newburgh for these boats. The large passenger boats are now nearly all made with iron hulls at the yards on the Delaware, and as the tendency is strongly in this direction at present the wooden steamboat building of the river is expected steadily to decline. Oak and pine are so costly upon the upper Hudson that iron will now make advances.

Since the adoption of iron for the hulls of the Long Island Sound boats and the coasting propellers steamboat building has steadily declined at New York city, and all the large business has been transferred to the Delaware river. Several large engine and boiler shops still exist, and an immense amount of work, both new and old, is done by them every year. Many of the Delaware river hulls receive their machinery in New York city, while the Morgan iron works supply nearly all the engines required by the iron propellers built at Chester. Excursion and river steamers for New York use, wherever built, also buy their machinery largely in the city; but so far as the building of the boats themselves is concerned the business has nearly disappeared, all that remains being the production of wooden tugs, small propeller yachts, wooden ferry-boats for local use, and an occasional excursion steamer of the river type for carrying passengers to and from the summer resorts in the immediate vicinity of the city. These vessels are seldom built within New York city itself, but are made in the ship-yards scattered along the water front of Brooklyn all the way from Hell Gate to the lower part of Gowanus bay. A few tugs are made at Tottenville, at the lower end of Staten island.

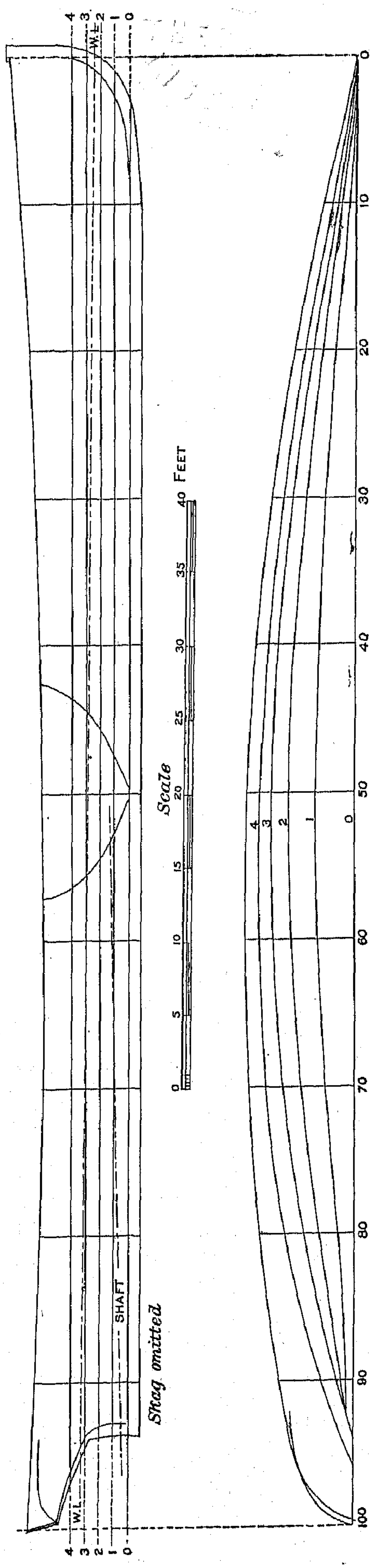


Fig. 49.—Water-lines of the steam-yacht Leila.

Bristol, Rhode Island, August 23, 1880.

The ferry-boats of New York are double-enders, sharp and swift, with side wheels, the deck highest amidships and dropping about 2 feet at the ends in a gradual curve. They are all of one general type, varying only in size. The machinery is stowed away in the hull as much as possible. The engine is low-pressure condensing, is often built with horizontal cylinder and piston, has a long stroke, and acts quickly. A narrow house rises in the center of the deck to shelter the machinery and cover the stairways to the hold, and on each side of this the deck is open for 10 feet, in order to allow horses and wagons to pass from end to end of the boat. The cabins for passengers are outside of the two gangways, one on each side of the boat, and extend two-thirds of the length, each cabin being in turn divided nearly in two by the wheel-house, which rises through it and leaves only a hallway 3 feet wide between the forward and after halves of each cabin. A roof covers the whole of the cabin, engine-house, and spaces between for teams, and the pilot-houses are on this roof, one at each end of the boat. A portion of the deck at each end is clear of structures of any kind, except the posts and chains needed to prevent the passengers and teams from crowding each other overboard while in the stream. These boats are an important feature of the business life of New York city. They run across the North and East rivers at numerous points, and from the city to Staten island, day and night, at intervals of from 5 to 30 minutes, according to the magnitude of the travel on each particular route. A large boat will carry 400 passengers and about 50 teams with wagons on a single trip. In the construction of this class of boats the New York builders have attained special excellence. The hulls are strongly but lightly framed with oak and chestnut and planked with oak, yellow pine being used for the rest of the vessel except the houses and the decking, which are of white pine and spruce, with cherry, black walnut, etc., in the joiner work of the cabins. They cost from $50,000 to $90,000 each, according to the size of the hull and the luxury of the cabins. The Jersey ferry-boat Princeton, of 888 tons, built in the census year, was one of the large class. She was 192 feet long, 36½ feet beam, and 12½ feet deep in the hold, and to build her it required 52,000 feet of oak, 10,000 feet of chestnut, 103,000 feet of white pine and spruce, and about 10,000 feet of yellow pine. Her machinery weighed 130 tons. Complete, the boat cost $85,000.

Steamboat building has taken the same course at the cities south of New York as it has at the latter port since the introduction of iron hulls, and the business has been absorbed in large measure by the iron ship-yards. Wooden boats are less in demand, and are only built for those whose capital is small and who need them for some special service. The yearly production is about as follows: At Camden, New Jersey, a few tugs, not to exceed five or six; at Philadelphia, two or three tugs, a yacht or two, and an occasional coasting propeller and small side-wheel steamboat; at Wilmington, an occasional tug and steamboat, some years none; at Baltimore, a steamboat every year or two for the Chesapeake bay business and three or four tugs; at Norfolk, sometimes nothing, sometimes a tug or a side-wheel steamer; at Elizabeth City and Washington, North Carolina, Charleston, South Carolina, and other points on the southern coast, an occasional light-draught stern-wheel boat, like a steam scow, for some local river service; at New Orleans, stern-wheel boats for the river and bayou trade. The whole wooden steam tonnage annually built at all these ports combined does not now equal the amount which was produced at either New York or Philadelphia alone in a single busy year before 1861.

On the Pacific coast steamboat building has developed slowly, owing to the lack of white-oak timber, which was long considered by builders the only wood fit for the hulls of the vessels. The practice has prevailed at San Francisco of ordering the finest of tugs and side-wheel boats in the East, where there has been a supply of oak timber, and where the art of constructing strong and light hulls has been thoroughly understood. Boats thus ordered have proved costly. In 1879 two side-wheel ferry-boats were completed at Oakland, on San Francisco bay, the hulls of which were gotten out in the East from oak and shipped by sailing vessels around cape Horn. These were the Garden City, of 1,080 tons, 210 feet long, 37 feet beam, and 13½ feet hold, and the Bay City, of 1,283 tons, 230 feet long, 36⅔ feet beam, and 13½ feet hold. The boats were put together in Oakland, the houses being built on them from Pacific coast woods, and the expenditure for labor, at $3 and $4 a day, was $33,000 on each boat. The iron was bought from a rolling-mill in San Francisco, and the engines for one of the boats from the Risdon iron works. When completed they cost $130,000 and $150,000 respectively, or one-third more than they could have been built for in New York city. The expense of this plan has led to the building of local vessels at home. A great variety of steam craft—tugs, ferry-boats, transfer steamers, propellers, and launches—have been made from Pacific coast fir within the last five or six years, one of the largest of them being the Transit car-ferry, built at the Central Pacific ship-yard in Oakland. This large vessel is 338 feet long over all, 316½ feet between perpendiculars, 40 feet beam, 75 feet wide over the guards, and 17½ feet deep from the beams to the keel, and is supplied with vertical condensing engines with 60-inch cylinders and 11 feet stroke. The wheels are 29 feet in diameter, carrying 20 paddles 12 feet long and 20 inches wide. A still larger one is the Solano, of 3,549 tons, a side-wheel transfer boat employed to ferry the overland railroad trains across the river. She is the largest transfer boat in the United States. Her dimensions are: Length, 407 feet; beam of hull, 65½ feet; hold, 17½ feet. Four tracks are laid upon her decks, capable of receiving 48 cars and engines. In the Solano sticks of fir were used for keelsons 150 feet long and 24 inches square. The engines are placed amidships, one behind the other, and the wheels, instead of being placed at the ends of one long paddle shaft reaching across the boat, are situated opposite the engines that drive them. The boats built of native fir have done so well that there is now no probability of further orders being sent to the East, except, possibly, for engines. There are many handsome oak and pine tug-boats in San Francisco bay, the Monarch, of 195 tons, standing at their head. She was built on the Delaware in 1873, and is about 95 feet long, 20 feet wide, and 16 feet deep, drawing $14\frac{1}{2}$ feet of water. Fir has been found latterly to answer as well for this class of vessel as any other timber, and as iron and machinery are now produced in San Francisco at moderate cost the city appears to be nearly independent of the eastern ship-yards.

A large wooden propeller was building in the upper part of San Francisco in the census year, and has since been launched. She is the most ambitious steamer built on the coast, and as she appears to be a complete success her construction is expected to give an impetus to the building of coasting vessels. The Mexico (Fig. 50) is a three-decker, 288 feet in extreme length, 275 feet between perpendiculars, 36 feet beam, and 28 feet deep below the spar deck, and is constructed entirely of Puget Sound fir with the exception of a few scattered pieces, which are of eastern white oak and Pacific Coast laurel. A statement of her scantling will allow a comparison to be made with oak and pine propellers in the East. The keel is in three lengths, 76, 106, and 108 feet, 16 by 22 inches square, with 11-foot scarfs and a 4-inch shoe. The keelsons are in pieces, some of them from 113 to 117 feet long. The main keelson is 16 by 23 inches, in three depths, with two $1\frac{3}{8}$-inch bolts clear through each frame and the keel; the sister keelsons are single logs of 16 by 23 inches, fastened with $1\frac{1}{8}$-inch iron bolts. The frames are spaced 27 inches, floors and futtocks sided 10 inches and top timbers 9 inches, and are molded 18 inches over the keel, 15 inches at the bilge, and 6 inches at the upper deck. There are two floors to each frame amidships, filled in solid under the engines, and at each end there are at least 8 frames with floors cut from natural crooks. The frames are bolted to the keel with two $1\frac{1}{8}$-inch iron bolts. The stem and apron are of white oak and laurel; the stern-post is of oak, molded 22 inches, and sided 16 inches at the keel and 28 inches at the center of the propeller shaft. The rudder-post is sided 13 inches at the keel and 16 inches at the counter, and is molded 18 inches. Both posts are secured to the keel with composition braces, one on each side, and one is fitted on top of the keel within the propeller space, each brace cast in one solid piece. The after deadwood and shaft box each have a heavy knee on the stern-post. Ceiling of the floor, 5 inches, fastened with $9\frac{1}{2}$-inch spikes; on the bilge 12 inches thick, in four streaks, each 14 inches wide; thence to the lower deck, 10 inches; the 10- and 12-inch stuff edge-bolted with $1\frac{1}{8}$-inch square iron in every frame space; from the lower to the main deck, 6-inch ceiling, edge-bolted with 1-inch square iron, with two $\frac{7}{8}$-inch bolts through each frame; from the main deck to the rail, 3-inch ceiling, spiked on. Clamps of the lower deck, 14 by 16 inches, in long lengths; main deck, 12 by 16 inches; upper deck, 8 by 12 inches. Water-ways of the lower two decks, 14 by 16 inches, in long pieces; plank-sheer, 4 by 14 inches. Planking: garboards, 10 by 16 inches and 7 by 14 inches; 5-inch planking to the main deck; 3 inches above that, all in lengths of from 40 to 100 feet, fastened with copper and locust treenails below the 14-foot water-line and with galvanized-iron spikes above. Beams of the lower deck, spaced $4\frac{1}{2}$ feet, 12 by 14 inches square in the middle and 12 by 9 at the ends. Main deck beams, 12 by 12 inches square, tapering to 8 by 12 at the ends; spaced $4\frac{1}{2}$ feet; upper deck beams 7 by 10 inches square, tapering to 5 by 10 at the ends. Knees of the lower deck, one hanging at each beam end, sided 10 inches, and 9-inch knees for the main deck. Two 11-inch hooks and pointers in the lower hold forward, with an 11-inch hook under each deck. The frame is single-strapped with $4\frac{1}{2}$- by $\frac{3}{4}$-inch iron, set 6 feet apart, running from the main deck to the lower turn of the bilge, and riveted into a 5- by $\frac{3}{4}$-inch iron band running clear around the ship at the main deck. Amidships, four sets of straps cross each other at right angles. The decking is $4\frac{1}{2}$, 4, and $1\frac{1}{4}$ inches, coming up from below. Three iron bulkheads of $\frac{1}{4}$-inch plates are fitted into the ship abaft the chain locker, forward of the coal bunkers and aft of the engines respectively. There were used in this vessel 70 tons of salt, 300 tons of bolts and straps, and about 900,000 feet of fir timber, and she cost \$250,000 ready for sea. Her model is a good specimen of the coasting propeller of the present day.

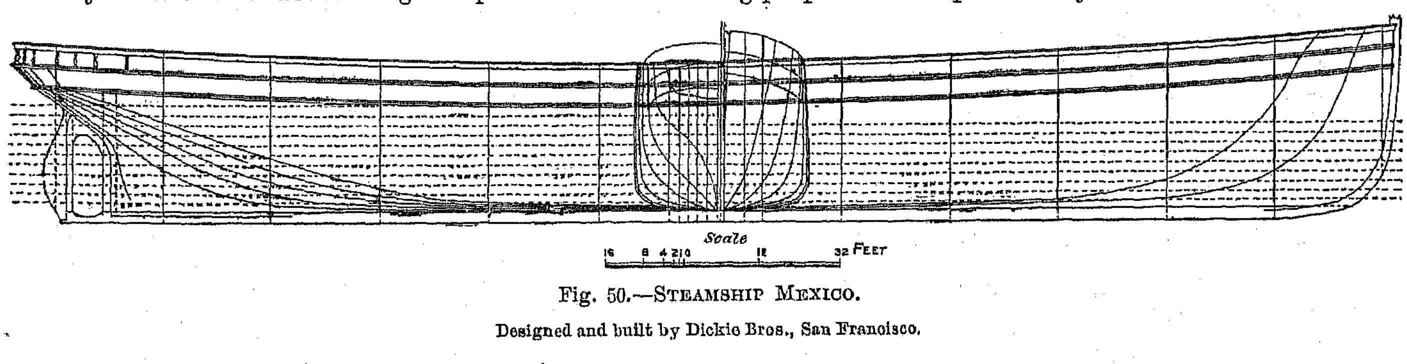


Fig. 50.—STEAMSHIP MEXICO.

Designed and built by Dickie Bros., San Francisco.

ON THE COLUMBIA RIVER.

From the Cascade mountains to the sea-coast Oregon is covered with an almost unbroken and impenetrable forest of yellow fir, cedar, pine, hemlock, and hard wood; but in the valley of the Willamette, and along the Columbia and the Snake rivers, eastward of the mountains, the country is open and is suited to agriculture. Population has followed the coast and the rivers. The first settlements were made at Astoria, near the mouth of the Columbia, by fur traders, and agriculture in the valleys and lumbering both on lands adjoining the rivers and at a few points on the sea-coast have been the occupations of the people.

The great highways of travel and trade in Oregon have been the noble Columbia river and its branches. Ocean steamers from San Francisco ascend the river to Astoria and Portland, and the merchandise and passengers which they bring have been distributed to other towns by a numerous fleet of local steamboats. The same boats, seconded by river barges, have brought back the grain and other produce destined for export, either to San Francisco by steamer or to Europe by sailing vessel. There is a small industry in building ocean vessels at Coos bay, on the coast, which has already been described in the chapter on sailing vessels. It now remains to describe the steamboat and barge building of the Columbia and its branches.

It is reported that the first steamboat building on the rivers was in 1850; since that date Portland has built many steamboats, and others have been built at Oregon City, Salem, The Dalles, Celilo, and Wallula. There has also been some work at Astoria. The excellence of yellow fir was first exemplified by experience at Portland. Among the early vessels was the side-wheel steamer Eliza Anderson, built in 1858 in that city. Winter-cut timber was used in her frame, and the boat stood on the sandy beach of the river, exposed to the sun and weather, one whole summer before she was planked; thus she became thoroughly seasoned, and proved an excellent and durable boat. About five years ago she was taken out of the water at Seattle, Washington territory, for repair, and her copper taken off, and it is said that after the vessel stood on the ways long enough for the bottom to dry the planking began to drop off, the fastening having become corroded by the galvanic action of the copper and salt water. The plank and the frame, however, were both bright and sound, and even aft of the wheels, where decay is most likely to take place, the fir was almost as good as new. A number of the other early boats showed the same longevity even when not salted; some did not, but the decay of the timbers has been traced to the fact that the wood was cut at the wrong season of the year and was not properly seasoned. The builders of the Columbia have had to learn by experience what they might have learned from the yards on the Atlantic coast, that timber proves lasting only when cut in the months when the sap had ceased running and when properly seasoned after being cut. When experiment had shown that the fir was a good material, steamboats, barges, and schooners were built as fast as they were required by the local trade of the state. In 1850 there were built 2 schooners, of 122 tons; in 1870, 1 schooner, 5 sloops and barges, and 11 steamboats, a total of 988 tons; in 1879, 11 steamboats, aggregating 5,383 tons; in 1880, 1 schooner, 2 sloops, and 13 steamers, a total of 2,466 tons; but since 1880 there has been an advance.

The first steamboats on the rivers were side-wheelers; but they were not the best for the business of these shallow rivers, and the later ones have been stern-wheelers. The Portland builders have been successful in producing a class of boats which vie with those of the Ohio in light draught, carrying power, and speed combined. It will be noticed elsewhere in this chapter that Ohio river boats have a rounded bow, with a long rake to the stem, which fits them for making landings alongshore, as the nose of the boat can be pushed up to the bank almost anywhere. The bottom is straight clear aft to the stern-post, and the run is formed by fitting two stern-posts, each carrying a rudder, into the stern 20 feet apart, and then modeling the stern as in ocean vessels, but suiting the requirements of two stern-posts. On the Columbia the boats are built differently. Forward, the keel begins to rise 15 or 20 feet from the bow and joins a rocker-stem; aft, the stern is not molded, but the bottom begins to rise 20 or 30 feet from the rudder and nearly reaches the surface of the water at the stern, which, above water, is cut off square. The boat is prevented from sagging by iron rods hooking into the keelsons away forward and aft and running up through decks and cabins to the top of central masts, and when they are in place they are screwed up until they take the weight off the bow and stern, and the vessel then keeps her shape perfectly.

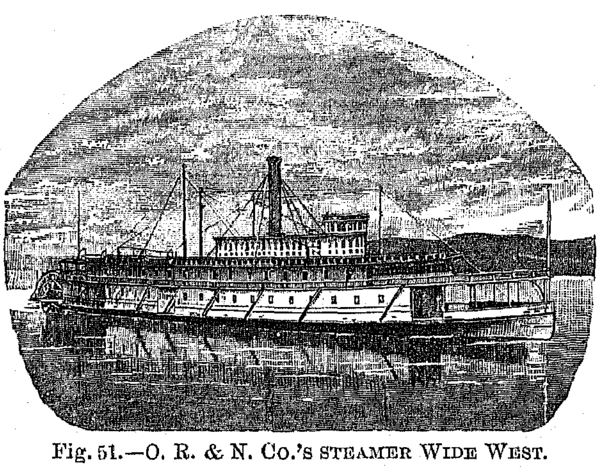


Fig. 51.—O. R. & N. Co.'s STEAMER WIDE WEST.

One steamer built in the census year was the D. S. Baker, which was 165 feet long, 36 feet beam, and 5 feet hold, with a sharp bow and a square stern. The house covers the vessel from the stern forward to within 20 feet of the bow. The engines and the cargo space are on deck, and the cabins for passengers are built above the main house. The hull measures 302 register tons and the houses 408, a total of 710 tons. The stern-wheeler Hassaloe is 160 feet long, 31 broad, and about 5 feet deep. She has smaller houses, and registers 461 tons. The Frederick Billings is 199 feet long, 37 broad, and 7 feet deep in the hold, has towering cabins, and registers 1,236 tons. The smaller Columbia river boats range from 60 to 75 feet in length and 15 to 18 feet beam, and are each from 4 to 5 feet deep in the hold, the register being from 40 to 60 tons. The handsomest vessel on the river at present is the stern-wheeler Wide West (Fig. 51), built for passenger service. She is 215 feet long in the hull, 12 feet deep, molded, just aft of the bow, 10 feet deep amidships, the stern rising until the molded depth is only 7½ feet. She is of 1,201 tons register. The guards are 3½ feet wide, and she has a long, sharp bow, the fore part keeping on an even line with the keel and the boat sitting up forward well out of the water. The lower house covers the whole of the deck to within about 25 feet of the bow, and shelters the boilers, engines, and cargo. On the deck of this house is built a long, handsomely-furnished cabin and dining-room, with state-rooms on each side. As on the Long Island Sound steamers, there is a promenade around the cabin and out to the bow; above the cabin there is a short texas, and on top of that is the pilot-house. The Wide West is a fast, comfortable boat, and her speed has not been beaten on the Columbia river. The hulls of the river boats are made of yellow fir; the houses of white cedar and fir. The boats all have fore-and-aft bulkheads, side keelsons, and hog-chains, as in the Ohio river boats, the main hog-chains, however, generally running up to a tall mast in the center of the vessel. There are no bridges across the Columbia to interfere with the freedom of the builder in choosing the best arrangement of hog-chains and braces.

The barges built for river service are of considerable size, and are used for bringing down grain in bags to Portland, Kalama, and Astoria for shipment to Europe. Several are each 150 feet long, 35 feet beam, and 4½ feet deep, square at both ends, and registering 260 tons, while others are 185 feet long, 36 feet beam, and 7½ feet deep, measuring 360 tons each. The Wyetchie belongs to a larger class. She is 200 feet long, 44½ feet beam, and 10 feet deep, with a house on deck 18 feet long, 9 feet broad, and 7½ feet high. She is sharp at both ends, and registers 621 tons. The barges nearly all have small houses on deck, as they carry deck loads of grain in bags; they are towed by stern-wheel steamboats. The grain business of the Columbia is rapidly increasing.

Some of the little schooners of the river are fitted with small propeller engines, for use when going against the tide and the current of the river. They trade from point to point on their own account, dealing in butter, eggs, and produce.

At Portland, on the Willamette river, near the Columbia, there are five boat-yards. The largest is owned by the Oregon Railway and Navigation Company, and is employed for the building of steamboats and barges. A large barge was building in the census year. The yard is well equipped. This company is now making a large fixed dry-dock in East Portland, in which the iron coasting steamers of the line to San Francisco can be docked and repaired. E. Sorenson, formerly of Manitowoc, Wisconsin, was building a propeller for river service 130 feet long on deck, 28 feet beam, and 10½ feet hold, to cost $40,000. The frame of this vessel was cut out with a band-saw, at a cost of $300 for labor and use of the saw. A frame of the same size was hewn out by him on lake Michigan, where wages are one-half what they are here, at a cost of $980. The butts of the planking were secured in this propeller by through bolts, the rest of the fastening being spikes and treenails, and the ceiling was put on with treenails. This vessel was built entirely of yellow fir, which cost $12 per thousand for frame flitch and $20 per thousand for decking, planking, etc., dressed on four sides, and these were the ruling prices for ship timber in Portland. In one yard there was building a government stern-wheeler 150 feet long and 28 feet beam. This boat had a rocker stem and keel forward, and the bottom rose several feet aft, the height of the sheer from the base line being 10 feet at the bow, 6 feet amidships, and 8 feet aft. Wages were $2 50 and $3 a day for laborers, $3 50 a day for young carpenters, and $4 a day for the majority of men in the yards. There is some repairing of boats at Portland, and one of the yards has a small railway.

At Oregon City and at Celilo there are marine railways for the Oregon Railway and Navigation Company's boats. The yards at The Dalles, Wallula, and Salem occasionally build small vessels.

At Astoria there is one regular yard, but some small building is done from time to time by various persons there and at Oneatta and Columbia City in the district. The work is of a scattered and fragmentary character, but it is enough to train in ship-yard work many persons whose services may become available at any day when there is a demand for ship-building. Ships of the largest class could be built at Astoria, Portland, and other good points in the Columbia River valley. This valley is exporting 200 or 300 cargoes of wheat to Europe annually, and the trade promises to expand rapidly. British ships get this business. They are iron vessels, while sound yellow fir vessels, which would carry grain as safely and as well, could be built on the Columbia for two-thirds their cost. Timber is abundant and cheap, and yellow fir, cut at the proper time of year and put into a vessel in the summer time, when it can dry and season, is as lasting as white oak, and being lighter than oak, will make a more buoyant vessel, and thus a better carrier. There was building at Astoria in 1881 only one vessel—a large propeller tug, 110 feet long, 21 feet beam, and 9½ feet hold, to draw 9 feet aft and 7½ feet forward. The frames are 12 by 16 inches, 10 inches at the bilge, 7 at the plank-sheer, spaced 22 inches; garboards, 5 inches; bottom plank, 3½ inches; wales, 4 inches; ceiling on the bilge, 6 inches; clamps, 5 inches; beams, 10 by 10 inches, spaced 38 inches. In the floor timbers some tide-land spruce, taken from the roots, was used on account of its crooked shape. The stern-post and rudder-posts were white oak; the arch knee over the propeller was spruce; while all the rest of the tug was yellow fir, including the knees and hooks, which were fir roots. Mr. Whelan, the builder, bought his material for $12 a thousand right through. The knees cost 75 cents per inch of siding, and wages were $4 a day. The tug-boats of Astoria are powerful and handsome vessels. Each carries one mast, with a yard for the sail forward of the pilot-house; but some of them have second masts aft of the cabins, carrying schooner sails. Scow sloops are built to some extent for fishing and river cruising about Astoria.

NORTHERN LAKES.

When Fulton began his experiments on the Hudson river, on the shores of lakes Ontario and Erie only was there any white population. The pioneer of lake steamers was the Ontario, of 232 tons, built at Sackett's Harbor, New York, in 1816. She was 110 feet long, and was a side-wheeler. One followed at Kingston, Canada, of 700 tons. The second on the American side was at Black Rock, New York, in 1818—the Walk-in-the-Water, of 342 tons. In the next ten years there were twenty steamboats built on the two lakes, the most of them on the American side, and all side-wheel boats, for the local service of the towns on the lakes. Unlike the Hudson river boats, those of the lakes had to encounter rough water and stormy winds, and were accordingly built with strong, deep hulls, like sailing vessels. Each generally bore at least one mast, for spreading sail in case of the breakage of the machinery; in size they ranged from 50 to 892 tons, the majority being from 250 to 400 tons register.

In 1829 an event occurred which stamped a special character on all the vessels trading between the lakes, steamboats included. The Welland canal was opened to enable the tonnage of one lake to pass through to the other. The smallest locks were 110 feet in length and 22 feet wide, with 8 feet draught of water—a size which permitted the passage of a boat carrying 400 tons. After the opening of this canal hulls of sailing vessels took the bluff, full form ever since peculiar to the lakes. The bows were made round, the bottoms flat, and the bodies straight, in order to reach the greatest capacity that could go through the locks of the canal; all steamboats that were intended to pass from one lake to the other approximated that form of hull, but they were not very numerous. Those intended for the local passenger traffic of each lake kept a sharp form; but they were never so sharp and shallow as those on the Hudson river.

The building towns on the American side were Sackett's Harbor, Oswego, Rochester, and Black Rock, New York; Erie, Pennsylvania; Cleveland, Huron, Black River, Sandusky, and Toledo, Ohio; and Detroit and Monroe, Michigan, oak, chestnut, and pine being abundant in all these localities. Afterward steamers were built wherever there was a ship-yard of any size. Many were side-wheelers, ranging in size from 250 to 600 tons, with an occasional big steamer of 700 tons; they had low-pressure engines, with walking-beams oscillating in the air above the cabins, and were in every important respect, save that of depth and strength of hull and their one or two masts, like the eastern river steamers.

As early as 1818 the Walk-in-the-Water had run to Detroit, and as fast as the country along the lakes filled up with settlers the steamboats followed, carrying fresh legions of immigrants, and supplying them with the manufactured goods and general supplies which the necessities of a new country required. About 1830 steamboats were running regularly to Chicago, and this added 650 miles to the 270 miles of navigation from Buffalo to Detroit. After the Welland canal opened, in 1831, the first increase of the lake steamboats was in the direction of the number of boats. The increase in size came later.

The era of large boats began in 1844 with the construction of the Empire, of 1,136 tons, at Cleveland, Ohio, and the Niagara, of 1,084 tons, at Buffalo, in 1845. These boats were too large for the Welland canal route, and were expressly intended for the passenger traffic from lake Erie ports to those on lake Michigan; but three years afterward, in view of the rush of travel, others were undertaken. In 1848 there were built the Globe, of 1,200 tons, at Trugo, Michigan; the Queen City, of 1,000 tons, at Buffalo, New York; the Bay State, of 1,100 tons, at Clayton, New York; and the Empire State, of 1,700 tons, at Saint Clair, Michigan. These were long, sharp, and fast boats, with towering cabins, handsome and elegantly furnished, and were the pride of the lakes. They were oak built throughout, save that the decks, some of the beams, the houses, and spars were of white pine, were well salted, and, like most of this class, were long lived. Vessels increased in magnitude and cost year after year until the Plymouth Rock was built in 1854 at Buffalo. This vessel was of 1,991 tons register, and was 310 feet long, 42 feet beam, and 12 feet hold, being 60 feet wide over the guards. In 1857 a similar steamer, named the City of Buffalo, was built at Buffalo. This was the culmination of side-wheel steamboat building on the lakes, and since that period this class of boats has steadily declined in size, popularity, and importance. The railroads along shore began as early as 1857 to draw away the flourishing passenger traffic, and no boats of the size of the Plymouth Rock were afterward built with side wheels on the lakes. The City of Buffalo was converted into a propeller; the Western Metropolis, of 1,860 tons, was changed into a bark; the Mississippi, of 1,829 tons, and the Western World, of 1,000 tons, were dismantled, and the hulls converted into floating dry-docks at Cleveland; a large hull was converted to the same use at Buffalo, and another at Erie, Pennsylvania; others were changed into barges; and in one way and another all the large passenger boats went out of use, and their places have not since been filled. Most of them were relegated to freighting during their active existence; and while a few of this type of vessels have continued to carry passengers, yet that branch of their business is now merely nominal, as travel exists only on few routes. Paddle-wheel steamers are now rarely built of greater size than 600 or 800 tons. From first to last, over 300 side-wheel boats have been constructed on the American side of the lakes, including lake Saint Clair, and, in addition, about one-third of that number are known to have been built on the Canada side. Not more than three or four a year are now produced.

One cause of disappearance of side-wheel boats has been the growing preference for the screw-propeller. It was better fitted to the Welland canal traffic than the paddle-wheel, the greater width of the latter class of boats completely excluding large side-wheel craft from that trade. Boats fitted with propellers could keep their narrow beam and make the trip through the canal with ease and safety. The screw is now almost the only wheel used on the northern lakes. The principal reason, other than the above, which has caused the preference in its favor is the fact that the harbors of Oswego, Buffalo, Cleveland, Chicago, and Milwaukee are rivers and canals, and consequently demand a narrow class of steam-vessels. Large numbers of the old side-wheel boats were changed and the new style of wheel put into them.

The first propeller on the lakes was the Vandalia, of 138 tons, built at Oswego, New York, in 1841, a bluff-bowed boat, with cutwater, bowsprit, and foremast and a sloop sail. She had a long cabin aft of the mast. Her machinery was well aft, and her smoke-stack was very nearly in the stern. She made a trip to the upper lakes in 1842. In ten years 53 propellers had been built at Oswego, Clayton, Dexter, New York, Buffalo, Cleveland, Maumee, Huron, Black River, Detroit, Saint Clair, Grand Haven, and Milwaukee, a total of 17,000 tons; they ranged in size from 150 to 700 tons, all except 10 of them being under 400 tons, so as to make the passage through the Welland canal. The popular size was 350 tons, and they bore a strong resemblance to fast Erie canal boats fitted up for lake navigation. The boats were all strongly framed, planked, and ceiled with white oak, were well salted and proved durable, and usually did good service for 30 years unless they met with some casualty. The Canadians enlarged the Welland locks to 150 feet in length, 26½ feet in breadth, and 10 feet depth of water, completing the work in 1853, and the change allowed vessels of 600 tons to pass from lake to lake. A few propellers for the canal were built, but the freighting of the lakes required large boats. An immense business had sprung up in carrying iron ore from the Michigan mines to Cleveland and other ports and grain and lumber from places on lakes Michigan, Huron, and Erie to the easternmost cities they could reach. Coal and merchandise were going back in large quantities from points on lakes Ontario and Erie, and Canada turned as large a share as possible of the eastward-bound grain and lumber destined for export to Europe to the lake Ontario and the river Saint Lawrence route. The facilities she created for the purpose would have led also to the building up of Oswego, New York, as well as of Kingston and Montreal; but she did not go far enough. Trade grew so fast that larger boats were demanded than could go down even to lake Ontario, certainly larger than could go to Montreal, and after 1855 a large number of screw-propellers of from 650 to 950 tons register were built, nearly all of them at Cleveland and Buffalo. In 1856 12 were built at Cleveland, aggregating 6,823 tons, and 14 at Buffalo, aggregating 8,633 tons, with 1 at Detroit of 862 tons and 1 at Milwaukee of 583 tons, as against only 2 side-wheel boats built in that year. This represents the actual building of the year. Some of the vessels were not documented at the custom-houses in the year they were launched. The boats were employed in trading from points above Detroit to Cleveland, Erie, and Buffalo.

In 1862 the B. F. Wade, of 1,120 tons, was built at Newport. Other large propellers followed, among them the Idaho, of 915 tons, and the Winslow, of 919 tons, at Cleveland in 1863; the D. Richmond, of 1,083 tons, at Cleveland in 1864; the Colorado, of 1,118 tons, at Buffalo, and the Roanoke, of 1,069 tons, at Cleveland in 1867; and after them vessels of from 1,200 to 2,000 register tons at all those places and at Detroit. With a view still to direct the export business of the lakes to Montreal, Canada has been enlarging the Welland and Lachine canals again, increasing the locks to 270 feet in length, 45 feet in width, and 14 feet depth of water. The work is now, in 1882, about completed, but again trade has grown fully up to the capacity of the canals. The most profitable propellers and schooners of the upper lakes are now from 1,600 to 2,000 register tons. They are from 270 to 280 feet in length, and draw 14 feet of water, and only by close squeezing and by lightening the boats at the entrance to the canals (reloading them at the port below) can they be employed in the canal traffic. Those longer than 270 feet, of which the number is large, cannot go into the canal. It must be said, however, that a medium class of iron steamers, drawing not over 14 feet of water, to which they are limited by a ledge of rocks in the Saint Clair river, and carrying up to 2,500 tons of grain, could be safely and perhaps profitably put into the through trade of the lakes, and preparations are making in Canada for trying the experiment. The distance from Chicago to Montreal is 1,261 miles, 1,005 miles of the route being lake navigation; from Chicago to New York, by way of Buffalo, the distance is 1,419 miles, of which only 865 miles are lake navigation.

Owing to the panic and the stop put to railroad building the freighting of iron ore and of coal fell off immensely, and building on the lakes was considerably depressed after 1873 for a few years. Since 1878 the business has revived, and is now brisk. New vessels have again come into demand, and at present about 25 propellers are required every year by the commerce of the lakes.

From 1841 to 1882 there have been built on the northern lakes more than 600 propellers varying from 50 to 200 tons for tugs and 130 to 2,000 tons for the passenger and freight business. The majority have been and are now employed exclusively in freighting, and are called "steam barges", in distinction from the class of boats which have houses from end to end for the accommodation of passengers. A barge has a small house aft, two stories high, to cover the machinery and to serve as quarters for some of the officers, and a small house forward, in the extreme bow, serving as a top-gallant forecastle, with a pilot-house atop. Between the two houses the spar deck is clear. It has one, two, three, and sometimes four masts, according to the fancy of the owners. The mizzen-mast seldom spreads a sail, as it is planted in close proximity to the smoke-pipe, and is used simply as a derrick for handling cargo. The propellers carry coal, grain, iron ore, and lumber.

The placing of the machinery away aft is a peculiarity of lake propellers. When light, the boats present a strange appearance, the bow being high up out of water and the hull down by the stern, and it is only when loaded that they sail on anything like an even keel. The practice of stowing the machinery aft is a convenient one with regard to the handling of cargo, and has only one disadvantage, that of tending to strain the hull when making trips in an unloaded condition. The lakes experience much heavy weather, and a hull working up and down in the waves with the stern as a fulcrum weakens rapidly amidships. To strengthen the hulls against this peculiar stress the builders of the lakes adopted the hog-frames of the side-wheel steamers for use in propellers. As soon as they began to build up to 175 and 200 feet in length some device of that sort was absolutely necessary, and as the hog-frame was the simplest means of gaining longitudinal rigidity, it was universally adopted, although undergoing some modifications in form. Instead of making the frame out of long, straight beams, united with iron rods, and giving it the angular appearance of a bridge-truss, the practice grew up of giving it the form of an arch, sweeping in a long, low, unbroken curve from end to end of the ship. The top chord was made out of several thicknesses of 4- or 6-inch oak plank, fitted so as to break joints, and strongly bolted together throughout the whole length, and was united to the hull with wooden braces, iron rods, and straps, the same as the ordinary hog-frame. It passed down through the deck and along the ceiling to the apron forward, the inner part aft being fastened to the hull in the strongest manner and secured with breast-hooks and braces. This was called the Bishop arch, from the name of the inventor. In the late propellers, say within the last five years, the hog-frame and the Bishop arch have both been discontinued, because they are both in the way, especially in handling lumber. The builders gain rigidity now by strapping the hulls with iron on the outside of the frames, by ceiling them heavily with oak, often bolting a broad arch strongly to the inner side of the timbers in the hold, and by augmenting the size and number of the keelsons. The propellers thus built strongly resemble ocean vessels in outward appearance, and are excellent boats in every respect.

Like the sailing vessels of the lakes, the propellers have to be built with flat bottoms, in order to carry full cargoes on a draught not exceeding 14 feet. The bottom being almost flat amidships and carried well forward and aft, the bilge is necessarily quick, being often described with a radius of not more than 18 to 24 inches. To strengthen this flat bottom the frames have double floors carried nearly from bilge to bilge, and a large number of keelsons are introduced. The central line of keelsons is usually composed of a main keelson about 16 by 32 inches, with a sister keelson each side about 14 by 26 inches. In some of the more recent large vessels the backbone is composed of three keelsons, side by side, 16 inches deep and 14, 16, and 14 inches wide respectively, with two rider keelsons atop, side by side, each 14 inches square. Floor keelsons parallel to the main are then put in, varying in size from 10 by 13 inches to 12 by 13 inches, according to the fancy of the builder, and from 12 to 20 inches apart. In all there are from 10 to 12 strakes of keelsons on the floor of the vessel in large propellers; in small propellers there is a great mass of keelsons in the center, with none at the sides. The bilge is strengthened with a few heavy strakes from 8 to 10 inches thick, molded to suit the curvature of that part of the vessel. The ceiling is then carried up in heavy strakes clear to the beams, being edge-bolted all the way up in the frame spaces. The spaces between the frames on the floor, and sometimes away forward, are generally filled in solid with white oak under the machinery, the filling extending a few feet up the bilge. Three methods are in vogue for flooring the hold. A usual method is to lay a course of 1½- or 2-inch pine or hemlock lumber athwartships across the floor keelsons, and on top of that another course of pine or oak planking about 2 inches thick, running fore and aft, trimming off all irregularities of the surface with an adze. A smooth floor is necessary, on account of carrying grain cargoes in bulk, the hold being cleared out, in discharging, with a steam shovel. A third method, a favorite one with the line propellers, which carry grain almost exclusively on the down trip, is to fit in a large number of chocks between the floor keelsons, their tops 3 inches below the tops of the keelsons. Three-inch oak plank is then laid on the chock flush with the top of the floor keelsons, the latter themselves forming a part of the floor. When the keelsons are massed in the center the flooring is laid on the frames, as in ocean vessels.

The beams of these vessels rest at each end on a broad shelf of oak plank from 4 to 6 inches thick and 2½ feet wide, to which they are firmly bolted; they are not kneed to the ceiling as in ocean vessels. The strake of the shelf next the side of the vessel is thicker than the one inside, and if there are three strakes the outer one is the thickest. The beam is cut to fit closely over the shelf-strakes and fays snugly to the ceiling. A heavy water-way is laid on top of the beam ends, and the beams are bolted strongly both to the shelf and the water-way. This arrangement of timber and iron makes the deck-frame a source of great lateral strength to the vessel. The beams are light, but are of white oak, and the manner in which they are secured protects the hull against racking stresses.

The sterns of lake steamers may be square, round, or elliptical, but the preference is for the elliptical stern, the old-fashioned square stern being now confined to sailing vessels. The overhang in propellers is from 12 to 18 feet, and the most convenient manner of framing it is to place in position a long and heavy "fan-tail" timber, resting on the deadwood and the head of the stern-post, and projecting the whole length of the overhang. The stern frames, or cants, heel on this timber.

It has become the fixed custom to supply propellers with masts and fore-and-aft sails, the sails being used almost constantly as auxiliary to steam; even when under a full head of steam every yard of canvas is spread if the wind favors. This practice has led to the introduction of center-boards to propellers. The freighting craft now have every requisite both of a good sailing vessel and a good steamer, and in this respect the propellers of the lakes are unique. The popular wheel on the lakes is the Philadelphia propeller, so called.

In the insurance rules for the characterization of lake vessels, drawn in 1875 pursuant to the action of a convention held in Buffalo in September, 1874, considerable stress was laid on the importance of adapting large vessels thereafter for transatlantic service. The Welland canal was soon to be completed, and the ocean service would permit of no looseness in construction; and rules were adopted for scantling, fastening, and freeboard suited to the broader field in which lake tonnage might thereafter possibly be employed. Builders have not been governed to any great extent by these rules, but owners have paid attention to them, and the result has been a decided improvement in the strength and excellence of hulls. Copper fastening has not as yet been introduced; but in all other respects the large lake vessels of the last six years have been so constructed as to adapt them to ocean service, and when the Canadian canals are completed more than a hundred staunch steamers could go at once into the carrying trade of the salt water.

LOCALITIES WHERE STEAMERS ARE BUILT.—On lake Ontario few steam vessels are now built. The railroads alongshore have deprived the water of a part of its carrying business, and tugs and canal-boats are now made to transact another part of it. The great side-wheelers and the numerous propellers of former times having nearly all disappeared, it is only now and then a steamboat or a tug is built on the American side of the lake, and then generally for some purely local use. Clayton, Ogdensburg, Oswego, and Irondequoit bay occasionally produce steamers, but the total production would not amount to more than three or four boats of small size annually. The scarcity of oak has had something to do with the change. The timber once grew in magnificent abundance, and ranged from \$6 to \$12 per thousand board feet, according to length and quality, but it is now scarce at \$25.

A number of ship- and boat-yards flourish at Buffalo on the banks of the canals, and among them there are four or five which build and repair lake tonnage. This city has been a leading center of the industry from an early day, and since 1860 has produced steam tonnage actively. The grain trade began in that year to assume immense proportions, springing from 30,000,000 to 50,000,000 bushels in one year, since which time it has been steadily growing. Buffalo has a large lake trade, and the expansion of business gave rise to the employment of a fleet of propellers of the heaviest class, a large proportion of which have been produced locally. The city has had the advantage of engine-building works and the possession of large insurance capital, and has also until recently been able to buy oak at reasonable prices. The large repair business of the port has also been an advantage. Three yards had large dry-docks and railways, with steady work for several hundred competent workmen, and so were equipped to do new work cheaply. In 1873 the panic in financial circles made ship-building dull for several years, but since 1878 the yards at Buffalo have all been quite active. In 1879 and 1880 a good deal of tonnage, large and small, was produced, among the rest the propellers Rochester and New York, of 2,000 and 1,920 tons, respectively. The New York was 269 feet long, custom-house measurement, 37 feet beam, and 16½ feet hold, with upper works, and was able to carry about 1,800 tons of cargo. The Rochester is a representative of the largest class now engaged in the lake trades. She is 287 feet long over all, 40 feet beam, 28 feet total depth of hold, with a carrying power of 2,200 tons. The keel of this vessel is 10 by 14 inches square, the frame 17 by 18 inches over the keel, the main keelson 16 inches square, sister keelsons 14 by 16 inches, and the floor keelsons 12 by 16 inches. The ceiling varies from 6 to 9 inches, and the planking is 4 and 6 inches. She is oak built throughout, except that the decking, houses, and some of the beams of the upper decks are of white pine. Following the late fashion, the hull is strapped with ½ by 5-inch iron, 4 feet apart. Two compound engines, with 2 steel boilers, comprise the machinery, which will develop 1,000 horse-power and drive the vessel at a speed of 12 knots an hour. To build vessels of this size almost a million feet of lumber have to be bought, and as oak in Buffalo cannot now be bought to advantage, the builders are beginning to feel the severe competition of the yards farther west, which are nearer the oak supply.

The next point is Cleveland, Ohio, where three yards are devoted to the production of large propellers. A builder who has been in business more than 33 years had built a few small vessels, when, in 1878, he went into the construction of large propellers. He built in 1878 the John N. Glidden, of 1,323 tons, 222 feet keel, 35 feet beam, and 20 feet hold; in 1880 the A. Everett, of 1,200 tons, 210 feet keel, 35 feet beam, 18½ feet hold; and in 1881 a propeller of 1,393 tons, 248 feet keel, 36½ feet beam, 19½ feet hold. These vessels were all two-decked and oak built, the frames, beams, ceiling, planking, keels, and keelsons being of that timber, while the deckings, houses, spars, and a few beams were of white pine. The frames were cut from 6- and 8-inch flitch and spaced about 22 inches from center to center. They were molded 16 inches over the keel, 14 inches at the bilge, and 7 or 8 inches at the plank-sheer, and as the timbers were not large enough to take treenails the planking was spiked on with bolts at the butts. Salt was freely used, a large quantity being placed between the frames in the usual manner, and the upper side of the beams was channeled and filled with salt and the keelsons thoroughly pickled. Hackmatack knees were used. The stem of a lake propeller is perpendicular, and the rule for the overhang of the stern is to extend it a little more than far enough to shelter the screw-wheel and the rudder. The three vessels of Mr. Radcliff consumed about 750,000 feet of white oak and 60,000 feet of white pine each, and cost about \$75,000 apiece.

A firm which began to build in 1850 have launched a great deal of heavy tonnage for the trade of Cleveland and the lakes generally, making a specialty of steam craft. In 1880 and 1881 they built two oak propellers, costing $100,000 and $125,000 respectively. The steam barge Columbia, of about 1,300 tons, was on the stocks in the census year. She was 236 feet long on the keel, 250 feet over all, 35⅔ feet beam, 19⅔ feet hold, and drew 6 feet 5 inches when launched. It required 750,000 feet of oak, 50,000 feet of white pine, and 125 tons of iron to build her, and the total cost was $120,000. The frame was molded 16 inches at the keel, 14 inches at the bilge, and 6 inches at the head, and the double frame sided 12 inches. A main keelson was put in 16 inches square, with a sister keelson on each side 14 inches square. Floor keelsons, 12 inches square and a foot apart, were laid away out to the bilge on both sides. In a sharp ship these logs could have been placed amidships, and would have made a center keelson 2 feet thick and 11 feet high, but the flatness of the floor made the distribution of the keelsons preferable. There were only 8 inches dead rise. The ceiling of the bilge was heavy, to match with the keelson, but tapered to 6 inches, which thickness it carried to the upper deck, and was edge-bolted from the bilge to the rail. The bottom plank was 5 inches thick; that of the sides 4 inches, square-fastened with iron spikes and butt-bolted clear through. No hog-frame was used in the boat, but an arch of oak 4 inches thick and 6 feet in depth was strongly bolted to the ceiling and frame on each side of the vessel, extending from the bilge within 20 feet of stem and stern and rising to the upper deck amidships. The beams were spaced 2 feet apart below and 3 feet above, and rested on strong shelves, which in turn were strongly supported by heavy hackmatack knees. The ceiling, arch planks, and beams were grooved for brine. The machinery was placed away aft, within 20 feet of the stern-post, and was composed of two low-pressure engines 3 feet in diameter, with 3 feet stroke, and a boiler 12 feet in diameter and 18 feet long. The latter, which was between decks, rested in a wrought-iron pan, sustained by 16 double T-iron beams, 17 inches apart. The screw was 11 feet in diameter—a fair type of the ordinary lake propeller.

Another firm at Cleveland (T. Quayle's Sons) builds oak propellers of the largest size engaged in the trade of the lakes. Among the product of their yards are the following:

Years.	Propellers.	Keel.	Beam.	Hold.	Tonnage.
		Feet.	*Feet.*	*Feet.*	
1878	Delaware	250	36	16	1,732
1878	Conestoga	250	36	16	1,726
1878	Buffalo	260	36	16	1,763
1879	Milwaukee	265	36	16	1,771
1879	Chicago	265	36	16	1,847
1880	Wococken	250	37	19	1,800
1880	Henry Chisholm				1,775
1881	John B. Lyon	255	38	20	1,710
1881	City of Rome	268	40	21	1,908
1881	Cumberland	250	37	16	1,601

For the length over all from 16 to 18 feet must be added to the length of keel, according to the size of the vessel. The first five of these boats were fitted with Bishop arches, or hog-frames, and had each one spar, a foremast. The others had no hog-frames, but were strapped diagonally with iron on the outside of the frame timbers and belted with iron at the top of the straps. Arches of iron plate a foot wide were bolted outside and inside of the frames. Each carried 4 masts, the forward ones about 95 feet long, with short topmasts, the jigger having no topmast and ending in a pole and ball. The large propellers each consumed about 950,000 feet of oak, 90,000 feet of white pine, and 130 tons of iron, exclusive of machinery and outfits. The firm had a new oak 1,800-ton propeller on the stocks in the census year 261½ feet long on the keel, 278 feet long over all, 38¼ feet beam, and 22½ feet hold, a four-master, designed to carry 1,900 tons of grain, which was being fitted with a center-board, for use when under sail. These lake propellers are always under sail when the wind favors, as well as under steam.

Wages in Cleveland ranged from $1 25 to $2 25 per day, the most of the men in the yard getting $2 and $2 25. It requires about 50 men, working nine months, to set a large propeller afloat, the labor bill being about $20,000. Oak costs about $25 per thousand board feet. In the round log, in rafts, it is delivered at the yard for $21 and $22 per thousand, and to saw it costs about $3 50 a thousand. The price of plank varies from $25 to $28. Before the war oak was bought in Cleveland for from $12 to $15, but the timber is now growing scarce. Cleveland has its own engine-building works, and thus possesses every facility for ship-building on a large scale. The yards here are all equipped in a thorough manner. The bevel saw is used for getting out the frames, and bolt-cutters, derricks worked by teams of horses, planers, steam-hauling apparatus, and every device known to man for simplifying and saving labor is employed. The large repair business of a port with an extensive lake commerce enables the proprietors of yards to keep their men together in the intervals of building, and thus they are always ready to take a new contract and perform the work promptly.

There are various places on the Ohio shore where fishing boats, schooners, tugs, and other vessels are built, but it is only at Cleveland that steamers are made a specialty. On the two rivers and the lake which connect lake

Erie with lake Huron there are a number of places dependent on Detroit for machinery which produce a great deal of steam tonnage. They are, in order, Gibraltar, Wyandotte, below Detroit, Marine City, Mount Clemens, and Port Huron, all in the state of Michigan.

At Gibraltar there is one large yard, fitted up in first-class manner, capable of constructing the largest sized wooden propellers. The builders undertake about one a year. They employ from 30 to 50 men, pay them fair wages (about $2 a day), do a quiet but prosperous business, and build from 1,200 up to 1,500 tons, at a cost of $70 or $75 a ton equipped ready for sea. Their steamer in the census year was 246 feet long, 36 feet beam, 19¾ feet hold, a two-decker with 4 masts, registering 1,399 tons.

The yard at Wyandotte is exclusively employed in the construction of iron vessels.

Detroit has three large ship-yards, at which is done a mixed business of building and repairing. The repair business of the city is extensive. Engine and boiler shops exist here in abundance, and in the city is owned an immense amount of tonnage, which naturally seeks the home port for carpentry, iron work, and refitting generally. Detroit is one of the old and prominent building places of the upper lakes. The panic of 1873 was felt here severely, and little was done during the four years of depression save the keeping of old boats in repair. The yards were almost idle, and the workmen became very much scattered. In 1877 the country had recovered from the shock, and a new demand for iron and lumber sprang up. Michigan was the state which chiefly supplied the East with these products, and the thrill of new life in trade quickly set in motion every ax and hammer in the ship-yards of Detroit. Since that time business has been brisk and growing; in fact, the demand for ship-carpenters has been so great that about 250 Frenchmen have been brought from Quebec and Montreal to supply the deficiency at the yards, and though not so efficient as Americans, they are docile and are now being rapidly trained, and will add materially to the resources of Detroit for ship-building. Two of the yards here are owned by an organization of large capital, which also owns the iron ship-yard at Wyandotte and employs the best available engineering talent. Its contracts for sail or steam or wooden or iron vessels are executed in whichever one of its three yards can best perform the work. In the yards of this concern in Detroit every form of labor-saving device is employed. The hauling of timbers, the fashioning of them for ship's use, and the handling and lifting are all done by steam- or horse-power; nothing is done by human muscle that can be avoided. The operations of this large concern are thought to indicate the strong tendency in the commerce of the lakes to concentrate enterprise in the hands of a few large firms having heavy capital. Men of smaller capital find it difficult to withstand this competition, because the big concerns can build and repair at a lower rate of compensation, just as they can operate the vessels when built at a lower charge for freighting. There were built two schooners of 528 and 859 tons respectively in the census year, and the following wooden steamers: propeller Iron Age, of 859 tons, 175 feet long, 34 feet beam, and 20 feet hold, molded, and the screw ferry- and river-boat Garland, of 248 tons, 110 feet long, 29 feet beam, and 10 feet hold, molded—all oak built. Wages were $1 and $1 25 a day for laborers, and $2 and $2 25 for carpenters and other skilled men. Oak was formerly $10 and $15 per thousand feet, according to length and quality; it is now $20 in the flitch, $25 in the squared timber, and $30 for first-rate plank. The growing scarcity of good oak was complained of, and the shortness of the stuff put into the frames, keels, and keelsons of vessels was noticeable. One builder was building a screw ferry- and river-boat with a long raking stem, for ice-breaking in the winter, 107 feet long over all, the keel and stem of which were composed of six pieces, only one of which was more than 28 feet long, and that not over 40 feet. In the frame there was not a stick over 12 feet long. In the yard of the Dry-Dock Company a steam barge was building 250 feet long and 37 feet beam, to register about 1,600 tons. The bottom amidships was almost flat, and the sides were straight from the very quick bilge to the rail. The form was well adapted to the use of long timber, and on Puget sound the frames would have been made of not more than ten pieces each, six of them from 20 to 33 feet in length, with four short ones at the bilge. In this vessel there were fourteen pieces in each square body frame, two of them not over 30 feet, and ten pieces under 14 feet each. Longer stuff would have been hard to get, and consequently was too expensive. The tendency in Detroit is now strongly in favor of iron steamers.

Mount Clemens is a pretty little village strung out along a bluff on a tributary of lake Saint Clair, a community of saw-mills, lumber yards, and stave factories. There are three ship-yards in the place. The town is surrounded with woods, which formerly yielded large oak in abundance. A few big trees are still cut now and then not far from the town, and some fine specimens of the old growth were to be seen at the saw-mills when visited, one log being seen which was 35 inches in diameter and 360 years old. At one mill they told of sawing a white-oak log 4½ feet in diameter and squaring 1,700 feet out of the tree, and a few years ago one was cut that was 6¼ feet through at the butt and 3¾ feet through 60 feet from the ground, furnishing five 16-foot logs. That gigantic specimen grew in a favored locality, and was probably not less than 350 years old. One oak tree was still standing near Mount Clemens 5 feet through at the butt. These giants of primitive growth are now rare, and in fact nearly all the large timber of this locality has been culled from the woods. Much of it has been squared up and rafted off to the markets on the lower lakes, and what is left is either small or grows on the uplands, where it fails to reach the perfection of the oak found in swamp lands. The best stuff put into Mount Clemens vessels now comes from swamps in Canada. It is a common practice here to buy the common stuff for a vessel in the woods, paying from $9 to $12 per thousand feet in the round log, delivered in the yard, getting the plank and better pieces in Canada. Plank costs from $20 to $26 per thousand, according to length; white pine $40 per thousand finished. Two or three small vessels for the freighting of coal, lumber, and grain are built at Mount Clemens every year. In the census year three steam barges were built, one of 325 tons for $30,000, the others smaller. Wages were $2 a day for the best men, but the majority of ship-yard hands got from $1 25 to $1 50. There was a large mingling of the lately imported Canadian French element among the men. Two medium-sized steam barges were on the stocks in the census year, and in one of them the builders were employing an original arrangement of the keelsons to gain longitudinal strength while economizing space. In most lake propellers the keelsons are spaced across the whole width of the floor and the ceiling laid atop of them, a plan whereby a foot in the depth of hold is lost. In this propeller they were assembled in the center. Five logs 12 inches square were laid side by side and strongly bolted to the frames and keel and to each other, and two riders were placed atop of them, each 14 by 16 inches and about 6 inches apart. In the forward hold an additional log, 10 by 12 inches, was placed on each rider; but for about half the length of the vessel forward of the machinery, where the stress chiefly comes, the 10 by 12 logs were replaced with 14 by 16 inch logs, which were sprung up 12 inches in the middle by oak blocks, placed at intervals. These two top strakes of the keelson took the form of an arch, and two strong bolts were driven through each arching log clear down through keelson, frame, and keel, imparting great strength to the structure. The vessel measured 160 feet on the keel, with 11 feet overhang of stern, 31 feet beam, and 11 feet hold. In general respects she was like other lake propellers.

Marine City is a small town on the Saint Clair river, and has about the same characteristics as Mount Clemens.

Port Huron, at the gateway into the lake of the same name, was formerly an active building locality. It is favorably situated at the entrance to the Saint Clair river, through which flows the whole current of the upper lake traffic, and there is an abundance of oak timber in its own county and all along the lake above. There are three large and well-equipped yards in Port Huron, but they do little except repair work. The panic of 1873 put a sudden end to the building of new vessels here.

East Saginaw and Bay City, both on the Saginaw river, and in the center of an immense salt and lumber business, build many fine wooden propellers for freighting. There are three yards in the former and four large yards in the latter. Schooners and tugs are also built, but the principal and the best product of both towns is in the line of large propellers. The industry has flourished for 20 years and more. The Saginaw river felt the effects of the panic of 1873 as much as the other lake towns, and a memento of that disastrous revulsion existed at East Saginaw in 1881 in the form of a center-board vessel in frame which had been begun in 1873. The panic came just as the frame had been set up. The payment of money stopped, and as the builder could find no one to aid him to complete the job the vessel was abandoned, the weather-beaten frames sagging and tumbling down into the grass that had grown all over the bank. This depression lasted about five years on the Saginaw river, and then there sprang up a new demand for lumber, which put life into every lumber-yard and ship-yard on the stream. In the census year business was brisk. Oak has always been cheap here, and the local builders still enjoy the advantage of buying at a slightly lower price than at any other point on the lakes. The peculiarities of the yards are the admirable manner in which steam has been utilized for as many purposes as possible and the thorough system employed in all branches of the work. The finest ship-yards for wooden ship-building in the United States are on the Saginaw river. Those at Bay City are four in number, of which one may be taken as a type of a northern lakes yard. A railroad runs past the yard, by means of which a great deal of the heavy oak is brought to the spot. The logs are rolled from the platform cars and lie upon the ground until called for, and a long rope from within the shops is attached to each log as it lies on the ground, or the end of the trunk is lifted up and supported by a pair of wheels and the rope is then attached. Steam-power is then applied, and the log is drawn across the railroad track down to the yard, through the gate, and along the beaten path to the saw-mill. It is there cut into flitch or square timber, as the case may be, planed, and passed on, all the while by steam-power, to a place in the yard where it can lie and season. The stick never changes end, and no steps are wasted in handling it. Whether designed to go through the bevel saw for fashioning into a frame or intended for the steam box to be softened for planking it passes on and on until it is finally lifted to its place in the vessel by a steam derrick. The yard has a complete equipment of bevel, jig, and joiner's saws, bolt-cutters, steam boxes, planers, treenail machines, and small tools. These arrangements were originally made necessary by the scarcity of labor; but they especially fulfill the purpose of saving expense in constructing the ship, and it is claimed that one-half of the labor formerly required is now saved. Nearly all the best yards on the lakes are organized on this plan. The Saginaw and some other lake builders launch their vessels sideways, a safer method than launching endways, owing to the great length of the vessels now required in the lake trade.

The Saginaw river vessels are built both for local owners and for others. A great deal of business comes from places even as far distant as Buffalo. Every new vessel can be immediately loaded with lumber and salt without leaving the stream. Oak is now brought from the interior by river and by railroad. Standing in the woods, it can be bought for $5 and $6 per thousand feet for short stuff and not exceeding $11 and $12 per thousand for long, and is cut, rolled to the water's edge, and rafted down, or is hauled to the railroad and placed on cars. At one yard in Bay City 1,500,000 feet of oak were floating in the river alongside of the wharf at one time in the census year. The cost of sawing in the yard is small, from $2 50 to $3 50 a thousand feet, and the slabs nearly or quite pay the expense, as a great deal of thin plank can be got out of them. Oak flitch can be bought from the saw-mills, delivered, for $17 and $18 per thousand; white-pine decking and finishing stuff costs from $35 to $40 per thousand. It is a singular fact that the builders of the lake Huron region buy their decking generally in Toledo and other lake Erie ports. The long white-pine logs are rafted thither from the Saginaw river, and the finished lumber is freighted back; but the local mills do not handle that kind of stuff, owing to its length. Wages at Bay City and East Saginaw are low. Carpenters get an average of $2, and seldom more than $2 25; laborers $1 and $1 25 per day. Cheap lumber and low wages guarantee the production of cheap ships.

The Oceanica, launched early in 1881 for a Buffalo owner, is a good specimen of the Bay City propeller. She measures 1,490 tons, was built for ocean service, if required, and is 250 feet keel, 265½ feet in length over all, 38¾ feet beam, 19½ feet hold, with two decks and three masts. She had the usual full-bottomed model, and was oak built and strongly strapped. The frames were cut from 6-inch flitch, and the floors were trebled to 4 feet up the bilge; they were molded 16 and sided 18 inches over the keel, and spaced 22 inches. The main keelson was 16 by 17 inches; the two sister keelsons were 14 by 13 inches. Six floor keelsons on each side of the main keelson were 13 by 12 inches, all securely bolted through the frames with 1⅛- and 1¼-inch iron. The thick stuff on the bilge was 11, 9, and 8 inches thick, with 6-inch ceiling above and 4 streaks of clamps 14 inches wide and 7 thick, all edge-bolted with 1-inch round iron. The shelf of the lower deck was 3 feet wide, 6 inches thick; of the upper deck, 3 feet wide; the middle streak 7 inches thick, the other two 6 inches. The outside plank is 5 inches thick, square-fastened with two bolts and two 10-inch spikes in every frame. Lower deck beams, 9 by 14 inches; upper deck beams, 7 by 10 inches, with 8-inch hanging knees under the shelves. The main strap, running around the vessel near the plank-sheer, is 10 inches wide and ⅞ inch thick, while the diagonal straps are 5 inches wide and ½ inch thick, and are riveted to the main strap and bolted through frames and ceiling. Amidships a few of the diagonal straps cross each other at right angles and are riveted to each other. The houses are away forward and aft, after the fashion of lake propellers, and the deck between is clear of everything and is very spacious. Five long hatches (long athwartships) are employed in handling cargo. The machinery for this vessel was prepared in Detroit, as is usual for the Saginaw river yards. The engines were compound, having a high-pressure cylinder of 30-inch bore and 40-inch stroke and a low-pressure cylinder of 50-inch bore and 40-inch stroke. The shaft was 11 inches in diameter, and carried a 12-foot wheel. Two steel boilers 9 feet in diameter and 16 feet long were put in. The lower masts were tall, the topmasts light; they were wire rigged, in accordance with the practice of the lakes. A Providence windlass was placed in the forecastle, with 1½- and 1¾-inch iron cables. It cost $125,000 to build and fit this vessel out. Her capacity was 2,000 tons of heavy cargo on 14 feet draught of water, and she was manned with 16 men.

There are a number of small towns on the lake Michigan shore where vessel building is carried on from time to time, but at only two were there any steamers built in the census year, namely, Saint Joseph and Grand Haven. There is plenty of oak in the shore counties yet; but the panic of 1873 made business dull until within two or three years, and it was not until 1881 that the ship-yards of Grand Haven and Saint Joseph had fairly got to work again. The production of the latter town in the census year was the propeller Sky Lark, of 260 tons, 123 feet long, 23 feet beam, and 8½ feet hold; the steamer Mary Graham, of 91 tons, a 96-foot boat; and the sloop J. C. King, of 14 tons, 35 feet long, 15 feet beam, and 5 feet hold. Facilities exist in the town for large work. Machinery is bought in Chicago. At Grand Haven, a large propeller was finished in 1881, after the close of the census year, 245 feet long over all, 35 feet beam, and 18⅝ feet hold, registering 1,187 tons—a fine specimen of the lake steamer. Statistics were obtained in regard to 5 tugs, 226 tons, costing $43,000, a propeller of 335 tons, costing $35,000, and a schooner of 152 tons, worth $15,000; all built in one year. There are two yards in Grand Haven with every facility for large work. Wages are the same as in other parts of Michigan, viz: $2 25 for best carpenters, $1 25 and $1 50 for cheap hands. Short oak can be bought for $6 a thousand standing in the woods and $8 and $10 a thousand for long. To cut, haul, and saw brings the price up to $16 and $17 a thousand for flitch and from $20 to $25 for plank. White pine is $30 for decking, and from $20 to $40 for the houses. Some Norway pine is used, but not much. It is cheap, but the Michigan men use very little inferior stuff in their vessels.

At Muskegon a few tugs are built yearly.

On the Wisconsin shore there are three places where steamers are built, Milwaukee, Manitowoc, and Green Bay, and these towns complete the list of localities on the northern lakes producing steam tonnage—fifteen in all. The two yards at Milwaukee are both equipped in the finest manner. Each has facilities for docking and repairing vessels; each has built a large number of tugs, schooners, and freighting propellers, and at one of them since 1868 more than 35 vessels have been set afloat. Milwaukee felt the hard times following 1873 severely, and not until the census year had the construction of new tonnage again become active. Each yard began a propeller of medium size, and the prospect was that the general revival of trade and freighting would keep the yards busy with new work. Three hundred ship-carpenters could be employed at each yard in repairing and building, but business had not in 1880 revived to an extent sufficient to employ more than that number in all the ship-work of the city. The chief disadvantage at Milwaukee is the lack of local timber, as the oak has been cut off and the yards have to resort to places farther down the lake, or over in Michigan, for all their supplies of oak and pine, and, in consequence, have to pay $5 or $6 more per thousand feet; but their superior equipment of labor-saving machinery has thus far enabled them to overcome this disadvantage in competing for contracts.

Manitowoc, situated in the midst of forests and reached by railroad only within a few years, thrives chiefly on the work of its three large ship-yards. The tonnage produced at this place was formerly in the line of schooners and tugs, but since the revival of business, three years ago, a number of steamers have been built, the preference of owners now being for that class of vessels. In 15 years one yard built 30 sailing vessels and 3 or 4 tugs. Another yard, founded in 1855, has in late years built 15 sailing vessels, 6 tugs, and 7 or 8 propellers, and in 1881 had under way a propeller and a large tug for the lumber business. The third yard has not as yet done much. A large tug was ordered by three firms which had a large number of sailing vessels in the lumber business and expected to use the tug jointly. In the chapter on sailing vessels it has already been stated how popular is the practice on the lakes of collecting a string of from four to eight schooners, loaded to deep-water line with lumber, salt, or grain, hoisting all sail, and aiding them on the voyage with a powerful tug or propeller, sailing far ahead and attached to the foremost vessel of the tow with a long cable. The new tug at Manitowoc was designed for this purpose. Her dimensions and scantling are as follows: Keel, 150 feet; beam, molded, 28 feet; depth, molded, 13 feet; keel, 13 by 15 inches square; keelson, 14 by 14 inches, with a rider 6 by 8 inches on each side of the stanchions; sister keelsons, 12 inches square. As the boat was sharp on the floor, no side keelsons were required. Frames, 10 by 12½ inches over the keel, molded 10½ inches on the bilge and 6½ inches at the head; spacing, 21 inches. Double floors were used, so as to avoid butts over the keel, and the frames were solid under the engine and bearings. Ceiling on flat of floor, 3 inches; bilge-streaks, 6 in number, 5½ inches thick and 9 inches wide, edge-bolted; above that to the clamps, 5 inches, square-fastened with 2 bolts and 2 spikes. Planking: Garboards, 6 inches; all the rest 4 inches, being 10 to 13 inches wide on the bottom, 8 inches on the bilge, 7 and 6½ inches on the wales, and 6 inches near the plank-sheer, square-fastened with 1 bolt and 3 spikes. Shelf, 30 inches wide, 5 inches thick, edge-bolted. Beams: Oak, 9 inches square, molded 8 inches at the end, notched over the thick streak of the shelf and dovetailed into the clamps; spacing, 30 inches; upper-deck beams, one of oak, 4 by 5 inches every 7 feet; the rest of white pine, 3 by 4 inches. Deck plank, 3 by 5 inches; upper deck, 2½ by 4 inches. There are two hooks with pointers at each end of the boat, with braces between those forward. Plank-sheer, 5 inches; main rail, two pieces, 4 by 6 inches, with two stringer pieces of the same size; hanging knees under each deck, 7-inch siding in the hold, tow-posts going through both decks, capped with iron and kneed and braced below. The bow of this powerful boat was covered with ¼-inch sheet-iron, to resist the action of ice, and the stem was ironed with a piece 4 inches wide and 3 inches thick, which hooded the edges of the plating.

The yards at Green Bay occasionally build steam craft. The locality is a favorite one with contractors who have no fixed habitation and with some who have offices in Chicago, who get their contracts in that city and go to Green Bay to build the vessel. Oak is abundant and cheap, and expenses of all kinds are low.

Steamer building on the lakes is prosperous, successful, and profitable. Builders have fitted up their yards admirably, producing vessels that have satisfied the requirements of trade at each stage of western development, and their business has flourished peacefully under the protection of the navigation laws of the United States, which reserves to American vessels the trade between different parts of our coast. Their vessels are cheap, staunch, and durable. The center of their industry has moved westward with the disappearance of the oak forests of the East; but this, as well as all other changes, has been strictly in the line of adapting themselves to the circumstances under which their operations are carried on. Steamer building is the growing branch of the industry, as competition with railroads is gradually converting the lake tonnage into vessels propelled wholly or in part by machinery. The supply of oak is giving out, but building does not slacken on that account, and yards are being established for the construction of vessels of iron.

ON THE WESTERN RIVERS.

The Mississippi river and its tributaries drain a region a million and a quarter square miles in area. Nineteen populous states and several growing territories use these streams as commercial highways. The total length of route available for steamboat navigation is about 12,000 miles, besides portions of streams available only at high water, which would swell the aggregate to some 14,000 miles.

These rivers, while having some features in common, have special characteristics. The Ohio, the scene of the busiest traffic and most active boat-building, runs through a country that was covered originally by a great hard-wood forest, and even as late as 1850 the banks on both sides were covered with dense woods, with scarce a break except where towns were planted. The upper part of the river, from Pittsburgh to Cincinnati, flows between hills from 200 to 300 feet high, but below Cincinnati the high banks recede, and the country is more level. The Ohio is subject to great fluctuations in the depth of water. In August and September the river is so low that sand-bars and ledges of rocks show up from the river bed with not more than 18 inches of water over them, and hundreds of steamboats have to be laid up at Pittsburgh and Cincinnati in consequence. Three times in the year the river rises, namely, in February, in May or June, and in November, the spring rise being the highest. At Cincinnati in 1832 the river rose 63 feet (a) above low-water mark. The commercial activity of this river is intimately connected with the periods of deep water. In preparation for a rise, thousands of flat boats and barges are loaded with coal and other goods in the upper tributaries of the Ohio, towing steamers for moving them being held in

a It has reached 65¼ feet in 1883.

readiness to take quick advantage of the flood, and when the water deepens to 6 feet it liberates the imprisoned fleets, and one after another they dart out from the Monongahela, Allegheny, Kanawha, and other streams and speed down the Ohio in rapid succession to their various destinations below. Intermingled with the tows of barges are large numbers of passenger and freight steamers, brought out to resume the traffic between the different river cities, and throughout its whole length the river is in a state of intense activity. The Ohio always has a rapid current; that is to say, from 2 to 3½ miles per hour in deep places and 7 or 8 miles over the shallows and in floods. There is one obstacle to the navigation of the Ohio, namely, the rapids at Louisville; but a canal has been built around them at a cost of $3,500,000.

The Mississippi river above Saint Louis is liable to fluctuations in the depth of water, but not to such an extent as the Ohio. There is seldom less than 4 feet of water all the way to Saint Paul, recent improvements having given that depth, and the river is available for navigation during seven months of the year. For five months the upper river is closed by ice, but below Cairo the river is never closed either by ice or low water. The whole stream is the route of a great commerce.

The Missouri river is not much navigated above Saint Joseph, although in times of deep water steamboats can run to Fort Benton, 2,600 miles from its mouth. The upper river is closed by ice five months in the year.

The southern rivers are seldom closed by ice or low water. At some points on the Tennessee wing-dams are used to deepen the channel, and at certain places windlasses have been established on the bank to assist boats against the current; that noble river affords passage to steamboats drawing 4 feet and less for a distance of 800 miles above and below the works in progress at the Mussel shoals, which interrupt navigation Most of the other southern rivers are subject to variations in depth, but they are all good highways.

The traffic of the rivers is largely of a general character, such as would naturally be expected to grow up between a number of cities having means of easy communication with each other. In addition, however, it has strong special features. Saint Louis and the Ohio river towns, Pittsburgh, Cincinnati, and Louisville especially, have long enjoyed a large trade in supplying the South with agricultural implements, wagons, and manufactured goods generally. Coal is also sent in immense quantities from the upper tributaries of the Ohio to the towns farther down the river and all along the Mississippi, and grain is sent in increasing bulk from Saint Louis for export. On the other hand, New Orleans supplies the upper towns with groceries, railroad iron, and a large variety of other imported goods. In the varying nature of the products of the different parts of the region permeated by the rivers, and in their varying needs, all the elements exist of a large internal trade and a busy river traffic. The navigation laws of the United States reserve the navigation of these rivers to American vessels exclusively, and foreign vessels are not permitted to trade above New Orleans.

Steamboating in the West is carried on under very different circumstances from that in the East, as will have been already seen. The system of intercommunication is of enormous extent; the rivers are swift and fluctuate in depth; and steamboating has been compelled to adapt itself to these peculiarities of the situation. The imperative necessity has been laid upon builders, in the first place, of obtaining the smallest possible draught. In the early days, while under the influence of deep-sea ideas, and while building boats with double frames and heavy scantling generally, the only resource for light draught was to give the boats a perfectly flat bottom; but in later years, especially after 1840, builders learned to add to the flat bottom a system of building with single frames and light scantling, which greatly lessened the weight of their vessels and made them marvels of naval construction. Light-draught construction has finally reached the perfection of a fine art, and nowhere else are vessels built which can carry such heavy cargoes on so small a depth of water, steamboats existing to-day which float at the 6-foot water-mark with 2,000 tons of goods aboard. Next in order, builders have been compelled to study how to supply their boats with machinery of great power without increasing their weight. To breast the flood of the rivers, and especially to guide tows of loaded barges through intricate channels, boats must have engine power nearly equal to that of ocean steamers. Originally the ordinary type of condensing engines was used, with walking-beam oscillating in the air aloft; but these were soon given up for a lighter type with stronger action. Condensation was dispensed with first, and the walking-beam next. The engines were brought up from the hold and laid horizontally on deck, one on each side of the boat, with pistons and long connecting-rods directly attached to the paddle-wheel shaft, and were worked with a pressure of from 50 to 150 pounds of steam, and with a long, slow, powerful stroke. Though consuming an excessive amount of fuel, this type of engine had the advantage of being stronger and lighter and of occupying less room than that of the eastern boats. A third peculiarity of the western boats has arisen from the ever-changing depth of water, and the consequent impossibility of employing fixed wharves for landings. On inland lakes and the coast rivers no country landing is without its little cheaply built pier. On the western rivers, wherever any structure is employed at all, it can only be of the character of a floating wharf, or wharf-boat—a broad, flat-bottomed, strongly built barge with square ends, having an overhanging platform and a large deck-house to protect the accumulations of freight and shelter the officers of the steamboat companies. These floats are employed at all towns having a regular traffic, and are moored by strong cables to iron rings, bolted into the heads of piles driven into the river bank, there being rows of these rings all the way up the bank, for use at different stages of the water. But wharf-boats are expensive structures, and cannot be employed in country places, where steamers only call occasionally. There are thousands of localities all along the rivers where small lots of goods and a few people must be put off or taken on from time to time. At these points the steamer must shove her bow slowly up on the sloping sandy beach, keep her wheel slowly moving, throw a plank ashore quickly, carry a line up to a tree to steady her, and effect the transfer of packages and passengers before the current of the river swings her off again. To qualify steamers for landings of this description they have to be built with full bows, having a long rounding rake, the forward deck being carried out on them as broad as possible, often, though not always, overhanging at the sides like a platform, and framed square across on a line with the stem. The great passenger boats usually have bows as sharp at least as those on Long Island sound, but the great majority of western steamers have the full raking bow. So far as the fourth point above alluded to is concerned—the vast extent of the river navigation of the West—its influence is chiefly in the large size of the boats and the great multitude of them. At the present time the fleet includes 1,198 vessels, measuring 251,792.85 tons register, and even this large fleet cannot move the traffic of the western rivers. Auxiliary to the steamboats there is an immense fleet of flat-boats and barges, towed by steamers, for the carriage of grain, coal, iron, building-stone, and general merchandise. So extended has been the production of these barges of late years that the city of Pittsburgh, Pennsylvania, now owns the most vessel tonnage of any port in the United States, having about 3,800 vessels of all kinds, measuring in all 850,000 tons. On all the western rivers tributary to the Mississippi there are now 5,397 flat-boats and barges, measuring 1,251,528.74 tons. The grand total of the tonnage of the rivers is 6,595 vessels; capacity, 1,503,321.59 tons. The barges are now exempt by law from registration.

The steamers of the West in the early times were mainly side-wheelers, though stern-wheel boats were built to a certain extent; but the preference until after 1850 was for vessels of the class first named. Up to about that date stern-wheel boats were not sanctioned by the insurance companies for the Missouri, Red, and some other western rivers, though for towing they were far superior. Since 1850 they have come into common use, and outnumber the side-wheelers about three to one.

Steamboating was introduced to the West by the same men who were the pioneers on the Hudson. Fulton and Livingston, having secured what they hoped would be a monopoly of the Ohio and Mississippi rivers, in 1811 built at Pittsburgh the little stern-wheel boat Orleans, of about 200 tons burden, rigged with masts and sails, the latter to be spread when the rivers were broad and the wind fair. Wood was used for fuel. The boat was regularly and strongly framed, but had no guards or upper works, and, like all the early boats, only one chimney. January 10, 1812, she arrived at New Orleans for the first time, her speed being about 3 miles per hour. This pioneer of the rivers ran for two years between New Orleans and Natchez as a packet, and was sunk by a snag near Baton Rouge in 1814. When the Orleans made this first trip down the Ohio the river was navigated only by small sailing craft and flat-boats, the latter pushed along with poles or rowed with long sweeps, like oars; but the superiority and success of steam was so instantly demonstrated that new steamboats followed as fast as the capital could be secured to build them. The Comet, a stern-wheeler with vibrating engines, was built at Pittsburgh in 1813, and also ran down to New Orleans, her machinery being sold there for a cotton factory. The Vesuvius followed, built at Pittsburgh in 1813 by R. W. Fulton, and sent, like the others, to the great river below. A small steamer of 50 tons was built at Brownsville, on the Monongahela, in 1814, and the same year the Etna, of 300 tons, was launched at Pittsburgh for the trade between Natchez and Louisville. Wheeling next caught the fever; some one there built the Washington, the first boat with two decks. The machinery, which in previous boats had been placed in the hold, was set up on the deck of the hull—a position it has since retained in all western river boats. The low power of the engines had made it practicable to employ her predecessors only on the lower Ohio and the Mississippi when the current was less than 3 miles per hour, and they could never ascend the swifter parts of the river after having once gone down. The Washington was, on the other hand, a powerful boat for her size. After she had gone over the falls of the Ohio at Louisville, she made two trips to New Orleans and back to Shippingport, (*a*) performing one round trip in 45 days. Her success was the signal for the construction of a great many small steamboats at different points on the Ohio river, on which stream all the early building took place, and which to-day still produces five-sixths of all the new tonnage of the West. By 1818 there were half a dozen yards around the falls of the Ohio river near Louisville. Engines were often put in at New Orleans. In 1818, at Cincinnati, was built the General Pike, famous in her day, intended for passenger traffic exclusively. This boat had a 100-foot keel and 25 feet beam, and a handsome cabin was erected on her deck between the engines. The central hall measured 40 by 18 feet, and at one end there were 6 and at the other 8 state-rooms for travelers. She ran as a packet between Louisville, Cincinnati, and Maysville. These early boats were all strong and durable, as they were built from the native oak of the Ohio and were framed and planked on the same plan as boats for the deep sea. The East at one time aspired to build vessels for the West, and in 1818 the Maid of Orleans, of 100 tons, was sent from the Philadelphia yards. She was a two-masted schooner, with steam-power, for use on the river. She ascended as far as Saint Louis in 1818, and was the first craft that reached that city from an Atlantic port. There were few ventures of that sort, however. The early steamboats were all small and of low speed; traffic was light in those days, and little was expected of the boats except to carry comfortably and safely the mails, a little general merchandise, and the few travelers who were compelled by political or mercantile errands to pass from point to point in the sparsely settled regions of the West, and if they could breast the current of the rivers and make any sort of speed at all they fulfilled the needs of the

a At the lower end of the falls, now included in Louisville.

times. After 1820 the country grew rapidly in population. Manufacturing developed along the Ohio, and special attention was paid to the needs of the South. New Orleans was building up a thriving foreign trade, and the basis was established for a large exchange of products between the lower and the upper portions of the river. Travel and trade increased; rival steamboats came into existence, which strove to excel each other in speed, size, comfort, carrying power, and general adaptability to the special requirements of the river trade; boat-yards were established all along the banks of the Ohio, at Saint Louis, and at New Orleans; and for more than 50 years steamboat building flourished in the West, reaching large proportions. The yards were scattered principally along the Monongahela and Ohio. Active work was done at Brownsville, Pittsburgh, Allegheny City, Sewickley, and Freedom, Pennsylvania; Steubenville, Marietta, Ironton, and Cincinnati, Ohio; Wheeling, Virginia; Newport, Louisville, and Portland, Kentucky; Madison, New Albany, and Jeffersonville, Indiana; Cairo and Mound City, Illinois; Saint Louis, Missouri; Dubuque, Iowa; Stillwater, Minnesota, and New Orleans. Besides yards at these places, a large number grew into existence at intermediate points for the repairing of vessels or for the building of barges and flat-boats, or for both repairing and building.

The early boats were all of low speed, as has been before noted, and up to 1818 no faster trip had been made from New Orleans to Louisville than 19 days. The Shelby had made the trip in that time with 51 passengers and a cargo of groceries, dry goods, etc., having stopped at ten places *en route*. Her running time was 15 days and 5 hours, but the usual time up the river was from 25 to 30 days. The fast steamer Cincinnati made round trips from Cincinnati to New Orleans in about 40 days, but once consumed nearly 100 days on the upward trip alone, having broken down *en route*, finding no place where repairs could be made until she reached Louisville. Efforts were finally made to improve the time of passenger boats, especially after 1830, and with such success that in 1838 the Diana made the run from New Orleans to Louisville in less than 6 days, winning a premium of $500 from the Post-Office Department for so doing. The passenger boats were side-wheelers, with pretty sharp bows and flat floors amidships, drawing from 4 to 6 feet of water, and were from 400 to 600 tons register. In the smaller boats the cabin was on the main deck aft between the engines. In 1838 upper cabins were rare, but they came into popularity later; cabins are now never placed on the main deck, except in a few ferry-boats. When the era of fast boats began, in 1830, the speed of every new-comer from the ship-yard was tested, and the course selected for this purpose was the lower Mississippi, which was deep and comparatively free from bars. Racing over this course from New Orleans to the cities north became the fashion after 1830, and has remained a feature of western boating to the present day. Rivalry reached such a point at times that both before and after the late war boats were sent over the course, stripped of every pound of cargo, baggage, and incumbrance, including even a part of the wood work of the vessel, and were driven with the full power of the engines and sent along without making stops, merely to beat the record of all previous trips and establish a reputation for speed. The passion for fast time and the carrying of steam at high pressure led to immense loss of life and property by explosions until legislation interfered and regulated the pressure of steam and the strength of the boilers. The speed of later boats has been secured not so much by an increase of steam pressure as by enlarging the cylinders of the engines. From 1830 to 1840 cylinders varied from 18 to 24 inches diameter in passenger boats, and occasionally they were larger, though not often; but in later steamers the diameter was increased to 30 inches, and since the war it has increased to 42 inches in many boats. The stroke has been 5 and 6 feet in small boats and from 8 to 11 feet in the large and fast ones.

Without following the development of steamboating in the West step by step through all its history, it will answer the purpose of this report to give a few data about particular vessels and then pass on to the facts about the boats and boat-yards of to-day.

From 1830 to 1840 the popular size was from 100 to 300 tons register; a few smaller craft were used as ferry-boats at local points, and there were a few large ones of from 400 to 600 tons engaged on the long routes. The following were fair specimens of the dimensions popularly used:

Length from bow to stern.	Beam.	Depth of hold.	Register tonnage.	Boilers.			Engines.	
				Length.	Diameter.	Number of boilers.	Diameter of cylinder.	Length of stroke.
Feet.	*Feet.*	*Feet.*		*Feet.*	*Inches.*		*Inches.*	*Feet.*
175	27	8½	440	24	42	8	25	8½
150	20	6½	166	20	40	4	22	8
165	28	7½	295	26	42	6	22½	10
230	28	8	600	30	42	6	25	10
180	21	4	112	20	38	2	14½	6
134	18	5	130	18	39	4	27	5½
130	18½	5½	180	18	36	3	18	5
130	19½	5½	129	18	34	4	20½	5
158	26	8	307	21	42	7	30	6½
153	28½	10	435	21	40	9	30	6
137	21	6½	200	23	36	6	24	5
169	27	10	440	21	40	7	32	6½

These boats had sometimes one, but generally two smoke-pipes, and the cabin was sometimes aft between the engines and sometimes aloft. They all had ample deck room for cargo.

After 1840 larger boats made their appearance for passenger service on the Ohio below Cincinnati, and on the Mississippi from Saint Louis to New Orleans. These boats were all side-wheelers, and were all built on the Ohio. One of the first was the fleet Sultana, built in 1843, which was 250 feet long, 35 feet beam, and 8 feet hold. Her boilers were 7 in number, 32 feet long, 42 inches in diameter, the engines 30 inches in diameter and 10 feet stroke, and the paddle-wheels 30 feet in diameter, with 14-foot buckets. This boat developed a speed of 15½ miles per hour going up stream, and made one trip from New Orleans to Louisville in 4 days 22 hours.

The Peytona was built in 1846 on the same measurements, except that she was 10 feet longer and had 6 boilers 32 feet by 42 inches; engines, 30½ inches in diameter and 10 feet stroke, and wheels 33 feet in diameter, with 16-foot buckets. She beat the time of the Sultana to Louisville by 2 hours. This boat once ran from Evansville to Louisville, a distance of 200 miles, with 300 tons of freight, in 13 hours, the fastest time ever made on that river, (*a*) the ordinary trip between those two points being 24 hours.

In 1852 the Eclipse was built at New Albany, just below the falls, and was one of the largest boats ever built in the West, being 363 feet long, 36 feet beam, and 9 feet deep in the hold. She was sumptuously fitted up with a richly furnished saloon-cabin and a texas or steerage cabin atop, had 8 boilers 42 inches in diameter and 32½ feet long and 2 engines 36 inches in diameter, and was the only boat of the day with 11-foot stroke. The wheels were 41 feet in diameter, with 15-foot buckets. How lightly built her hull was may be seen from the following data: Her frames were single, and were cut from 4- and 4½-inch flitch oak, molded 13 inches on the floor, 10 inches at the bilge, and 5½ inches at the heads. The main keelson was 12 by 16 inches, the bilge log 7 by 11½ inches, and there were 18 floor keelsons, varying from 3½ by 10 to 4 by 11 inches square. Fore and aft bulkheads of wood were put in to strengthen her. She was planked with 3½- to 4½-inch oak. The Eclipse was finished at a cost of $300,000, and for many years was the most fashionable and popular boat of the West. Her exploits were the pride of the people. In 1852 she ran from New Orleans to Louisville in 4 days 18 hours, and in the next year made the same trip in 4 days 9 hours 30 minutes, an average of 13¼ miles per hour, having lost 35 minutes *en route* by the blowing out of the packing of a piston. Her highest speed was 16 miles an hour. It must be remembered that this was up stream, as down stream it was not unusual for the Eclipse to make 25 miles an hour.

The A. L. Shotwell, built the same year as the Eclipse, was 310 feet long, 36 feet beam, and 8 feet deep in the hold. She had six 32-foot by 42-inch boilers, and two engines 30 inches in diameter with 10 feet stroke. The wheels were 37 feet in diameter, and had 15-foot buckets. The Shotwell was built sharp, with a view to speed, and was the only vessel that dared challenge the Eclipse. These two boats were racing when the latter made her celebrated record of 1853. Both were stripped for the effort, and carried neither passengers nor freight. Furniture, landing stages, and fenders were sent ashore, the bulkheads in the wheel-houses and part of the deck were removed, and everything was done that could be thought of to lighten the two boats and qualify them for the contest. The Shotwell, being the shorter boat, had the advantage in turning bends of the river, but she once ventured in too close, got aground, and lost 2½ hours, and thereby lost the race. Her running time, however, was very nearly the same as that of the Eclipse, and her record made her one of the most popular boats of that day.

Following these two famous steamers came a number of large and swift boats for the packet service from principal points to the South and back. These ranged from 250 to 300 feet in length, and were sumptuously fitted up with upper and top-gallant cabins. They were, in the main, side-wheel boats, this type having always been preferred for passenger traffic on the grand routes; some were, however, stern-wheelers. They were all usually owned in Pittsburgh, Cincinnati, and Saint Louis.

The war interrupted the river traffic for a period of four years, and during its progress a great deal of the old tonnage disappeared. After that traffic was resumed, slowly at first, but with increasing activity, and a fleet of new boats came out fully the equals of the earlier steamers, some of them of great size and speed. Two of them were the R. E. Lee, built in 1866, and the Natchez, built in 1869. The Lee was 300 feet long, 44 feet beam, and 10 feet deep, with engines 40 inches in diameter and 10-foot stroke, and wheels 38 feet in diameter, having 16½-foot paddles. The Natchez was very nearly of the same size, being 301½ feet long, 42½ feet beam, and 9½ feet in the hold, her engines, however, being 34 inches in diameter, with 10-foot stroke, and wheels 42 feet in diameter, with 16-foot paddles. In 1870 these two boats raced from New Orleans to Saint Louis, a distance of 1,200 miles. Both boats stripped for the race, and left about 5 p. m. of June 30, 1870. They kept each other in sight a large part of the way, made about 17 miles an hour on the lower river, and were only an hour apart at Memphis and at Cairo. The R. E. Lee reached Saint Louis in the unprecedented time of 3 days 18 hours and 14 minutes, the Natchez arriving 6 hours and 33 minutes later.

Among the large boats the Great Republic was built at Pittsburgh in 1867. She was 296 feet long, 50½ feet broad, and 9½ feet deep; not a fast steamer, but a capacious one, and a large carrier. In 1872 she was enlarged at Saint Louis, and then became 350 feet long, with a register of 2,441 tons. She was dismantled in 1879 and converted into a barge for towing.

a Henry Clay was on board.

In 1876 a steamer was built at Saint Louis called the Grand Republic, intended to be a monster passenger and cotton boat. She was 338⅝ feet long, 56⅝ feet broad on the beam, and 103 feet wide over the paddle-wheel guards, with a depth of hold ranging from 10½ to 17 feet. Her boilers were steel, 7 in number, 28 feet long and 42 inches in diameter. Two engines were 55 inches in diameter and 10 feet stroke, and were taken from the Great Republic, and two others were 26 inches in diameter, with 10 feet stroke. The power was immense. The wheels were 37 feet. State-rooms were supplied for 280 passengers, and the boat was so admirably built that she floated light at 32 inches draught forward and 48 inches aft, and on 10 feet draught could carry 4,000 tons of freight. Her cost was $190,000; her register, 2,600 tons. The boat was burned at her wharf in Saint Louis in 1877 while undergoing repairs.

Several large side-wheel boats came out in 1878, among them the Ed. Richardson, of 2,048 tons, and the J. M. White, of 2,028 tons, both remarkably handsome vessels, and good specimens of the side-wheel steamer of the West of the present time. The Ed. Richardson cost $125,000, and was 303 feet long, 48½ feet broad on the beam, and 10 feet deep in the hold. She had 9 boilers, 42 inches in diameter and 32 feet long, and the cylinders were 38 inches by 10 feet. The cabin was 140 feet long, from 26 to 45 feet wide, and 17½ feet high.

While many 300-foot boats have been built since 1878, that being a favorite length for the great Saint Louis packets, none have been built so large as the J. M. White. As a representative of her class she may be described in detail, and this description will answer for all the side-wheel boats, because others differ from her only in dimensions and the slight changes in scantling and size of engines due to the difference in tonnage. The hull of the J. M. White is 321 feet long, 48 feet broad on the main beam, 10½ feet deep in the hold in the shoalest place, the plank-sheer rising to 16½ feet at the bow and stern. This 6 feet of sheer is peculiar to boats built for the lower Mississippi, the river being too smooth above to require more than a faint rise of the deck forward. The floor amidships is nearly flat. The bilge is rounding and the sides are slightly flaring, and more than one-half the length of the hull amidships is straight, with only a faint taper in that part of its length. The bow is about 80 feet long, long and tapering, with hollow water-lines below, but flaring above, so that the deck may be carried forward as broad as possible, with 2 or 3 feet of guards. The after part of the boat is fuller. The hull is framed as follows: Keel, broad and flat; frames, molded, 11 inches, and sided 4½ and 5 inches amidships, increasing to 6 inches in the bow, with some of 4 inches aft; side timbers, molded 10 inches at the bilge and 5 inches at the head. The spacing varies from 14 inches amidships to 12 at the bow, with flitch side futtocks at the bilge. Main keelson, 11 by 18 inches; bilge or knuckle keelsons, 9 by 13 inches. Twelve floor keelsons parallel to the main, as follows: two, 4½ by 12 inches; four, 4 by 10; two, 6 by 10; two, 7½ by 9; two, 9 by 10½—this last pair supporting bulkheads and the heels of wooden masts or braces, over which the hog-chains of the boat pass. Ceiling, none, except that a light floor is laid on the bottom of the boat; three side streaks, or stringers, are fastened to the top-timbers on each side for rigidity, one of them being 3½ by 12, the other two 4 by 12 inches. Clamps, 4 by 15 and 3½ by 13 inches. The beams, 4½ and 4 by 9 inches, are supported by several long rows of slender stanchions resting on the floor keelsons, and by three fore-and-aft bulkheads, made by nailing light poplar planks to the stanchions. The planking is, like the rest of the boat, white oak, 4½ inches thick on the bottom, diminishing to 4 inches aft, 5 at the bilge, and 4½ tapering to 4 inches on the sides. Decking, 2½-inch white pine. The bow for 25 feet is solid oak and iron, with strong breast-hooks and braces, and the guards amidships are 22½ feet wide. A strong iron band weighing 2,500 pounds is placed upon the fore edge of the stem, running under the boat and ending on the keel. Fore-and-aft rigidity is not left to depend on the keelsons and bulkheads, but is gained chiefly by an elaborate system of hog-chains, so called; that is to say, of long iron rods stretching from end to end and from side to side of the boat. These rods fasten under the main and heavy floor keelsons and run up over the end of long rows of square pine masts and braces, which are set up on the keelsons perpendicularly amidships, but are inclined forward in the fore body and backward in the after body. The rods vary from 1½ to 2 inches in diameter, and contain about 58 tons of iron; by their agency the weight, both of the ends of the boat and of the guards, rests in part on the central portion of the boat. This system is universal in all the steamers of the West, and a hog-frame is never seen. The great width of the J. M. White, 95 feet, affords spacious deck-room for the boilers and engines and the stowage of cargo. The lower deck is covered with a roof or deck, supported on light stanchions, and the sides are all open forward, being closed at times against the weather by canvas awnings only. The wheel-houses and a part of the lower deck aft are inclosed; the cabin is built upon the upper deck. The main cabin is 233 feet in length, 13 feet high in the clear, and 19 feet wide, exclusive of state-rooms. The office is in the forward part of the cabin on one side, the bar-room on the other. Twenty-three state-rooms, 10 feet deep, line each side of the central hall, and there are two state-rooms 13 by 14 feet. Aft of the main cabin is a hall 17 feet deep and 46 feet wide, exclusively for ladies. Tables are spread in the main cabin, at which 250 guests can sit at dinner. The pantry, cupboard, barber-shop, etc., are on the upper deck, forward of the wheel-houses. A promenade deck 30 feet wide by 64 feet long extends in front of the cabin, which is reached from below by an ash and black walnut stairway. On top of the main cabin is the texas, or upper cabin, 180 feet long by 28 feet wide, with 50 state-rooms, including accommodations for the officers, the cabin-boys, a few first-class passengers, and the colored passengers. A bell weighing 2,500 pounds hangs in front of the texas. The pilot-house is on the roof, and is 15½ feet square and 17½ feet high. These upper works are of the very lightest and frailest description, the stuff being white pine and poplar ¼ and ½ inch thick, supported by a very light framing of pine and fastened with small nails. Steam-power is supplied by a battery of ten steel boilers, each 42 inches in diameter and 34 feet long, containing two flues 16 inches in diameter. The smoke-pipes are two in number, reaching to a height of about 75 feet from the main deck, showily ornamented at the top, their mouths flaring like enormous sunflowers with coarse petals. The boilers are allowed to carry 173 pounds of steam. The stowage space for coal is provided in front of and around the boilers. The engines are placed horizontally amidships, one on each side of the boat, having 43-inch cylinders with 11 feet stroke. They are of the regular lever, puppet-valve type, and are each placed on two massive parallel timbers built up of solid oak logs, called cylinder timbers, scarped and keyed together. These cylinder timbers are a feature of all western boats. Heavy oak stanchions are placed in the hold to support their weight, and strong iron rods run down to the keelsons, securing them in position. The cross-head of each piston runs on iron ways on top of the cylinder timbers, and a pitman 44 feet long connects the cross-head with the crank of the paddle-wheel shaft. The escape steam finds its way into the open air, in slow, strong puffs, from pipes that rise through the roof of the texas like small smoke-stacks. No racing steamer has ever had larger wheels than the J. M. White, as they are 44 feet in diameter, and carry paddles 19 feet long by 3 wide, and are driven at a speed of 18 revolutions a minute. With 100 pounds of steam the engines develop 2,800 horse-power and drive the boat at a velocity of 20 miles per hour. The cargo is stowed on the ample lower deck, and also in the hold, and there is room for 10,000 bales of cotton. Small engines are provided for raising freight from the hold and for working the capstans and the landing stages. The landing stages are two in number, about 50 feet long and 8 feet wide, being strong but lightly built platforms, and, owing to the lack of room for them on the deck and the frequency with which they have to be used, they are carried suspended in the air over the forward deck, projecting diagonally upward, like horns. There are 290 tons of iron in the fastenings, hog-chains, boilers, engines, and outfit of this steamer, and with this load and about 60 tons of water and 400 tons of coal aboard she draws 6½ feet, and on a draught of 10 feet will carry 250 passengers and 2,600 tons of freight. This boat was built expressly for the cotton-carrying and passenger traffic of the lower Mississippi, and cost about $220,000.

The following are the main data of size, etc., of a number of the leading side-wheel boats of the West, including those above enumerated:

Year.	Boats.	HULL.			BOILERS.			ENGINES.		WHEELS.	
		Length.	Beam.	Hold.	Number.	Length.	Diameter.	Diameter.	Stroke.	Diameter.	Length of paddles.
		Feet.	*Feet.*	*Feet.*		*Feet*	*Inches.*	*Inches.*	*Feet.*	*Feet.*	*Feet.*
1843	Sultana	250	35	8	7	32	42	30	10	30	14
1844	J. M. White	250	31	8½	7	32	42	30	10	32	15
1846	Peytona	260	35	8	6	32	42	30½	10	33	16
1848	Aleck Scott	285	84	7⅞	5	32	42	30½	10	....	....
1852	Eclipse	303	36	9	8	32½	42	36	11	41	15
1852	A. L. Shotwell	310	36	8	6	32	42	30	10	37	15
1855	Princess	280	38	9½	6	34	42	34	9	40	....
1866	R. E. Lee	300	44	10	8	32	42	40	10	38	16½
1867	Great Republic	340½	50½	8½	....	....	....	....	....	....	....
1868	Frank Pargoud	250	41	9½	7	28	38	32½	9	30½	15½
1869	Natchez	301½	42½	9½	8	34	40	34	10	42	16
1876	R. E. Lee	315	48½	10½	9	32	42	40	10	30	17
1876	Grand Republic	338⅔	56⅔	10½	7	28	42	55	10	37	....
1878	John W. Cannon	250	43	9½	7	34	42	34	9	37½	16
1878	J. M. White	321	50	11½	10	34	42	43	11	44	19
1878	Ed. Richardson	303	48½	10	9	32	42	38	10	....	....
1880	Natchez	304	46½	9⅔	....	....	....	34	10	....	....
1881	City of New Orleans	300	48	9	5	30	44	26	10	35	15
1881	City of Baton Rouge	300	48	9	5	30	44	26	10	35	15
	Belle Lee	300	43	9	....	....	....	....	....	....	....
1881	Edward J. Gay	250	40½	8½	6	32	42	27	48	....	....
	Annie P. Silver	300	41	8⅔	....	....	....	....	....	....	....
	John A. Scudder	300	50	8½	....	....	....	....	....	....	....

These boats draw an average of between 36 and 48 inches light and from 6 to 10 feet loaded, carrying from 1,000 to 2,600 tons of cargo. On the upper Mississippi the packets are smaller, varying now from 180 to 230 feet in length and from 35 to 40 feet beam, drawing from 4 to 6 feet loaded. They are of the same type exactly as those of the lower river. The use of side-wheel boats is now confined almost exclusively to the Mississippi river and the lower portion of the Ohio.

On the upper part of the Ohio, the Missouri, the Arkansas, and all the other tributary streams of the West, the passenger and freight boats, as well as the towing boats, are almost exclusively stern-wheelers (Fig. 52). Experience has demonstrated the superiority of the stern-wheelers for handling fleets of barges, and the peculiarities of navigation on the Ohio have given them the preference for the passenger and freight traffic of that

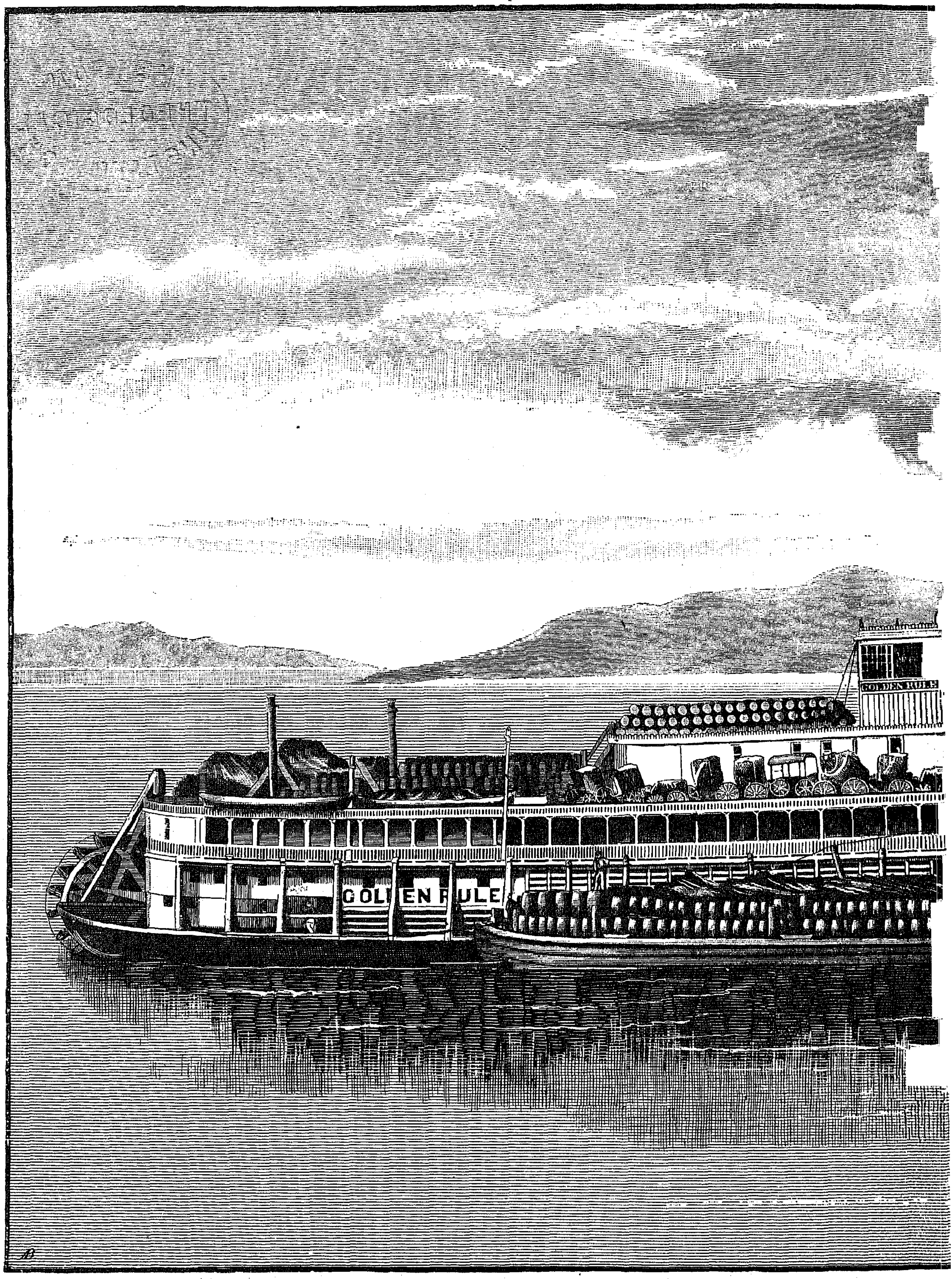
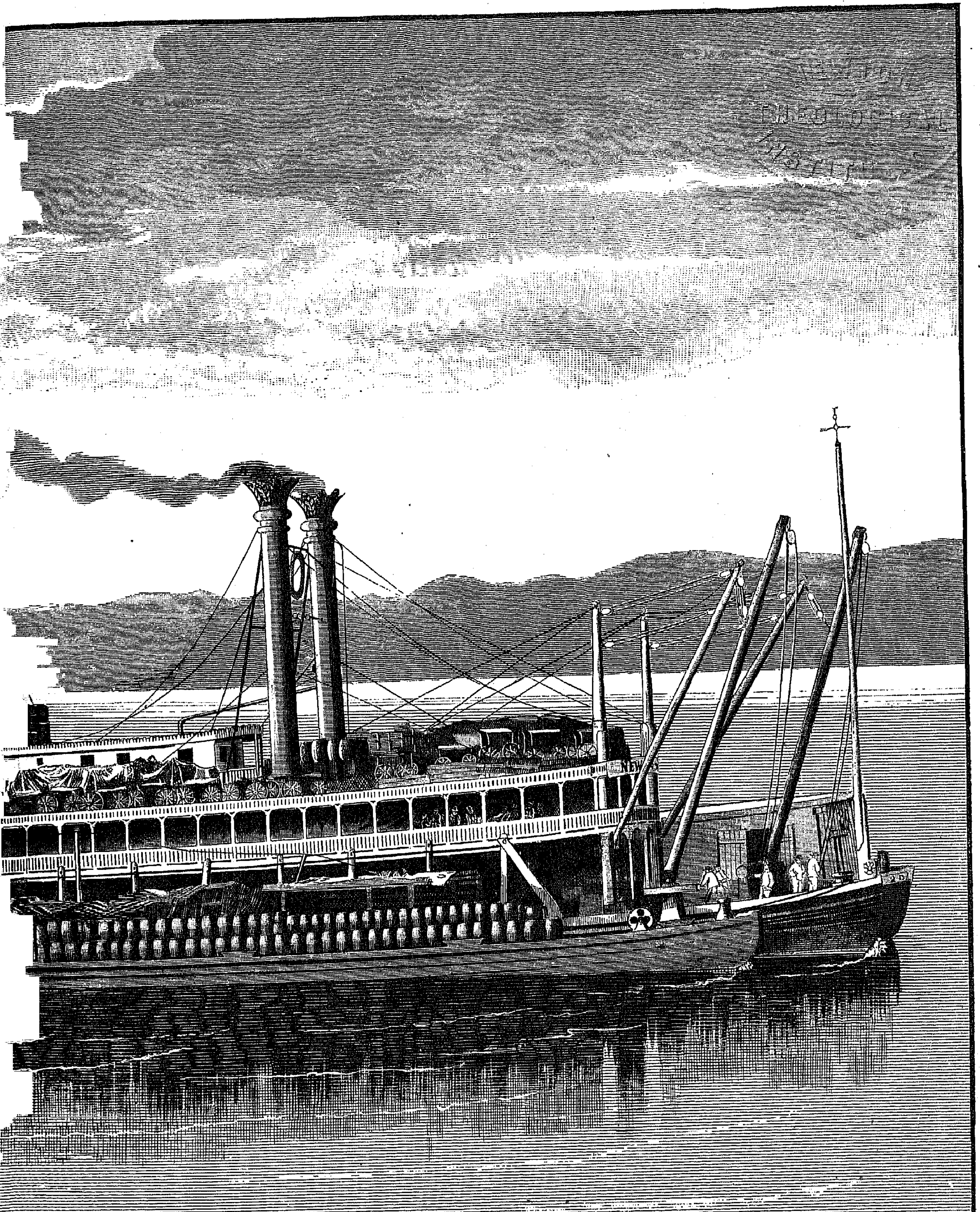


Fig. 53.—Stern-wheel passenge

881 tons, 265 feet long, 41⅗ feet beam, 6⅗ feet deep. At Cincinnati, prepared for a light-water trip to Cairo, the barge-loads there to be



AND FREIGHT BOAT GOLDEN RULE.

ansferred to the steamer for transportation to points on the lower Mississippi. One barge carries cargo, the other one both cargo and coal.

stream. The canal at Louisville is only 82 feet wide, and the largest stern-wheelers can slip through this channel with perfect ease, while on the other hand side-wheel boats usually measure from 83 to 95 feet over the guards, and are therefore shut out from the trade to points above Louisville. For another reason the river captains of the Ohio find it convenient to place the paddle-wheel aft. When the river is low the large boats bound for New Orleans cannot carry a full cargo without danger of grounding, and find it useful, therefore, to lay freight barges alongside of the steamer, one on each side (Fig. 53), loading one with goods and the other with coal and running in this manner to Cairo. At that point the whole of the cargo is transferred to the steamer. This is what they call "a light-water trip" on the Ohio, and for such purposes the stern-wheel boat is superior to all others. The placing of the wheel aft works a few changes in the build of the steamers. The wheel-houses and guards at the sides are dispensed with, the cylinder timbers are carried away aft and are made to project about

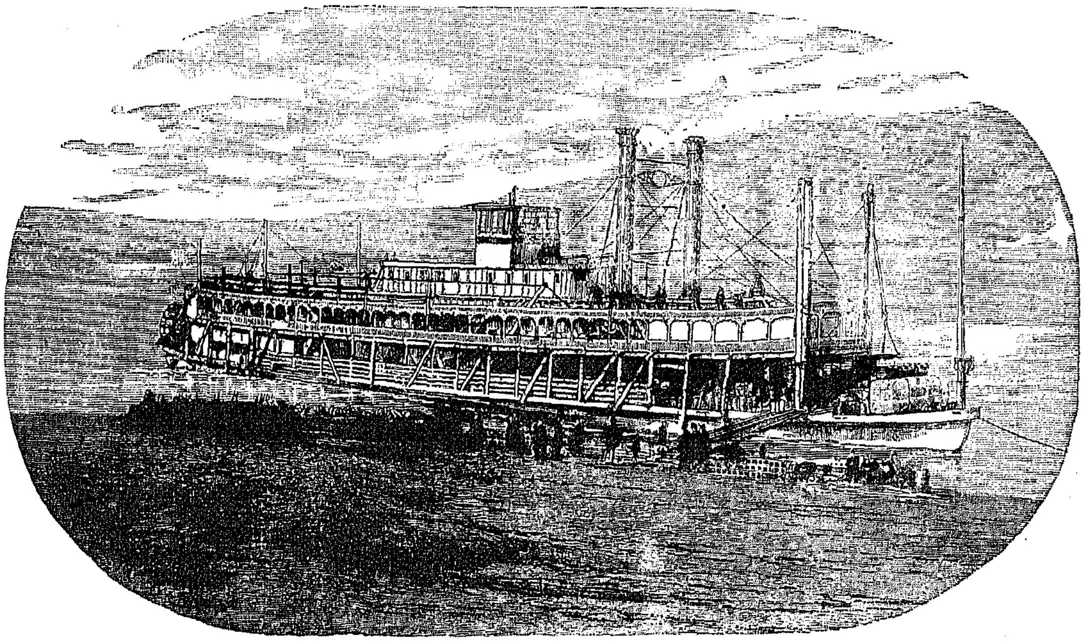


Fig. 52.—BUCKEYE STATE.

Built at Pittsburgh, Pennsylvania. Stern-wheel passenger and freight boat.

25 feet behind the hull, with a slight sheer upward; the paddle-wheel shaft rests on these timbers, and the system of hog-chains is extended aft, so as to support the weight of the large wheel and transmit the stress of it to the forward part of the boat. The only other important change is in the form of the hull. The model does not taper aft; it has to keep its full breadth on deck and on the bottom clear to the stern, so that there is no taper at all to the after body of the boat except for a few feet. The body is carried back square; the floor of the boat rises in the middle at the stern, however, so as to allow the water to clear easily, giving the stern the appearance of two hulls joined by arching timbers planked over. This form of stern permits the use of three or four rudders, those at the sides being hung on the upright stern-post, while those in the middle are hung on stout rudder-posts and project partly under the boat, being shaped on the balance-rudder principle. The bows of the stern-wheelers are all full and raking. The cylinder timbers in some of the stern-wheelers of recent construction are made of plate-iron, as are also the paddle-wheels, both being lighter in consequence.

The passenger and freight boats of this class are handsome vessels of from 200 to 265 feet in length and from 35 to 42 feet beam, and have from 6 to 10 feet depth of hold amidships, with ample cabins and upper works. Those that go down the Mississippi are given a good deal of sheer. They carry from 1,200 to 2,200 tons of cargo on 7 to 10 feet draught, their hulls being immersed to within a foot of the plank-sheer when loaded. The towing boats are not so large in the hull, and have small cabins, but they have stronger bows. They are now from 150 to 250 feet in length, and draw from 6 to 8 feet forward and not over 4 feet aft, the smaller sizes being used on the upper Ohio and in towing barges on the Mississippi. The great tow-boats make up large fleets of coal barges at Louisville below the canal and take them to New Orleans. The Ajax and the Harry Brown will take from 20 to 35 loaded coal barges at one time.

The average length of life of the western steamers is 7 years.

BARGES.—There are four classes of barges at present in use. The smallest is the flat-boat (Fig. 54), square and box-like, with a raking bow and stern, about 90 feet long, 16 feet wide, and 5½ to 7 feet deep, undecked, registering about 75 tons. Its use is always local on small streams for short trips for carrying about 115 tons of coal, stone, or other coarse cargo. Next is the coal barge, an open boat, strongly built, with raking ends, about 130 feet long, 24 feet wide, and $7\frac{1}{2}$ feet deep, registering about 225 tons, and carrying from 400 to 500 net tons of coal. The later boats are 135 by 25 by 8 feet. The majority of the barges are employed between the coal mines in Pennsylvania and West Virginia and the markets below all the way to New Orleans. They are valuable boats, and are almost always brought back after the down trip. The coal boat, or broad-horn (Fig. 55), is about 170 feet long, 25 feet wide, and $9\frac{1}{2}$ feet deep, registering about 375 tons, and carrying about 950 net tons of coal. The coal boat has a strong hemlock, pine, or oak bottom, but the sides are flimsy. It was formerly customary to leave coal-boats at New Orleans to be broken up for lumber, for the same reason that the immense multitude of grain barges which float

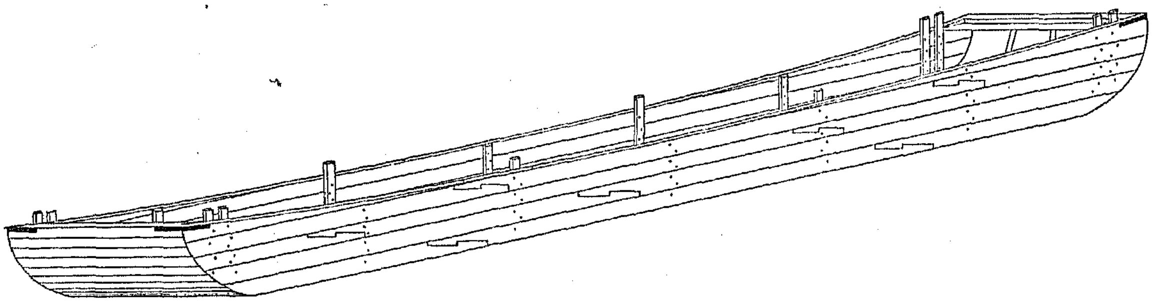


Fig. 54.—Flat-boat.

90 feet long, 16 feet beam, 6 feet depth of side; capacity, 115 tons. Coal barge; same model exactly, except that there is a bulkhead in each end.

down the rivers of Russia every year are not taken back. To tow them to Pittsburgh again, a distance of 1,900 miles, in the face of the current did not pay. Latterly, however, since the boats have reached a large size and have been better built, it has been cheaper to bring them back than to sell them, and the majority are now built for more than one trip. Next in order is the model barge. These boats have hulls built like steamboats, sharp at both ends, decked, and covered with a house or "cargo box" when used for package freights. The smaller ones are used on the Mississippi above Saint Louis for carrying iron-ore, ice, building-stone, and other coarse freight, of which each carries about 500 tons on 5 feet draught, while the larger ones, 235 feet long, are employed in the bulk grain trade of the Mississippi to New Orleans, and carry up to 1,800 tons of cargo on about 8 feet draught.

Flat-boats are built as follows: They are put together on a long row of stout wooden horses or building ways. The sides are built up of four, or, in deep boats, five tiers of solid white-pine logs, 8, 7, and 6 inches thick, laid one above the other, and strongly bolted together edgewise with square iron spikes. In another part of the country where boats are also built with "gunwale" sides, namely, on the Erie canal, the bolts go clear through from top to bottom, being driven with great effort by a heavy swinging hammer; but on the western rivers each set of gunwales is fastened on separately, the bolts through one tier being driven in the intervals between those of the tier below. The lowest gunwale is made of three logs, 8 inches thick and 18 inches deep, fitted together with 5- or 6-foot scarfs. The tier above is 7 by 18 inches, fastened with 11 spikes 28 inches long by $\frac{3}{4}$-inch square. A third tier of logs in two lengths, scarfed, is then laid on and fastened with 12 spikes 44 inches long and $\frac{3}{4}$-inch square, the spikes thus going down into the lower gunwales. The fourth or top gunwale is 6 by 14 inches square, in three lengths, fastened with 14 spikes 40 inches long by $\frac{3}{4}$-inch square. On top of this gunwale sheer pieces are placed at each end 30 feet long, 15 inches high at one end, tapering to 2 inches at the inner end. This is spiked on with light iron, generally with 24-inch spikes. Each side of the boat is made in this manner, each being laid flat on the row of wooden horses until bolted. The sides are then raised to a perpendicular position. The floor is constructed by laying a number of floor timbers of pine or hemlock, 6 by 12 inches in 5-foot boats and 7 by 14 inches in deeper boats, athwart a number of fore-and-aft floor streaks; they are put in about 12 feet apart, the ends tenoning into the lower gunwale, which is always heavier than those above. The floor streaks or "streamers" are four in number, of 3 by 9 inch oak, laid from end to end of the boat, being fastened under the floors with strong spikes. The bottom is then planked across with 2- or 3-inch hemlock, when it can be had; otherwise, with white pine or oak; sometimes the bottom is built wrong-side up and then turned over. The plank of the raking ends is supported by rake timbers, heeling into a floor timber below and capped at the top by a transom or fender of oak about 9 by 13 inches square, this log being connected to the sheer pieces at the corners of the boat by short straps of iron 6 inches wide and $\frac{1}{2}$ or $\frac{3}{4}$ inch thick. One strap is placed outside and another inside the corners of the boat, and the two are joined by screw-bolts through the wood. Oak or hemlock stanchions are set up on the ends of the floor timbers and bolted to the sides of the boat, and about 30 feet from each end of the boat one strong stanchion on each side is carried up above the top gunwale and shaped into a timber-head for towing purposes. A pair of stout oak bitts, 6 by 12 inches square, is put in at each end of the boat and fastened with strong screw-bolts, and usually a light bulkhead cuts off the raking ends of the boat from the rest of the hull, it being considered undesirable to allow the weight of the coal to rest there. Such a flat can be built with from 13,000 to 18,000 feet of lumber, according to depth, and 1,450 pounds of iron, and weighs from 18 to 22 tons, floating light at 4 from to 6 inches draught. These flats are well calked, but are not painted, and last six or seven years. The cost is from \$500 to \$650, depending on the size of the boat. The smallest item in the cost is labor, which, with wages averaging \$2 a day, does not exceed from \$85 to \$100.

The coal barge is merely a larger and better flat-boat. The average size has been given, but the trade now calls for barges 135 feet long, 25 feet wide, and 8 feet deep. About 150 coal barges are built every year on the Monongahela alone. Owing to their size the several tiers of gunwales are laid in three and four pieces each, the logs varying from 20 to 50 feet in length. There are about 6 tiers of gunwales, 8 inches thick below and 7 and 6 inches above. It requires 34,000 feet of lumber and 3,000 pounds of iron to build a barge, and the expense is from $1,000 to $1,200, from $150 to $190 being for labor. They weigh about 45 net tons each, and, like the flats, draw only from 4 to 6 inches of water light. A few have been built at Pittsburgh 160 feet long, 24 feet wide, and 8 feet deep.

For coal boats, or broad-horns (Fig. 55), the standard size is now 170 feet in length, 25 feet beam, and 9 or 9½ feet in depth of side; but they vary in dimensions, sometimes being a foot wider, and sometimes 2 or 3 feet shallower. One large firm on the Monongahela builds them 165 feet in length, 28 feet beam, and 8½ feet in depth, the capacity and cost in all cases being about the same. The coal boat has a barge bottom, with one bilge-log or gunwale about 9 by 16 inches square, strengthened at the scarfs by a piece inside 18 feet long, 4 by 16 inches square, fastened on with 10 large treenails, 7 or 8 screw bolts, and a number of spikes. This bottom is generally built of hemlock or of hard wood, whichever can be most cheaply bought in the locality. A sheer piece is put on top of the gunwale at each end. The ends of the bottom overhang as in a flat, and the tops are flimsily built. A long row of studs, about 6 by 2½ inches square, is set up perpendicularly on the bilge-log and sheer pieces, clear around the boat, from 32 to 36 inches apart, and these are simply and lightly planked over, generally with broad 1½-inch hemlock boards, though sometimes with white pine. A thread or two of oakum is driven into the seams, so as to make the boat water-tight for

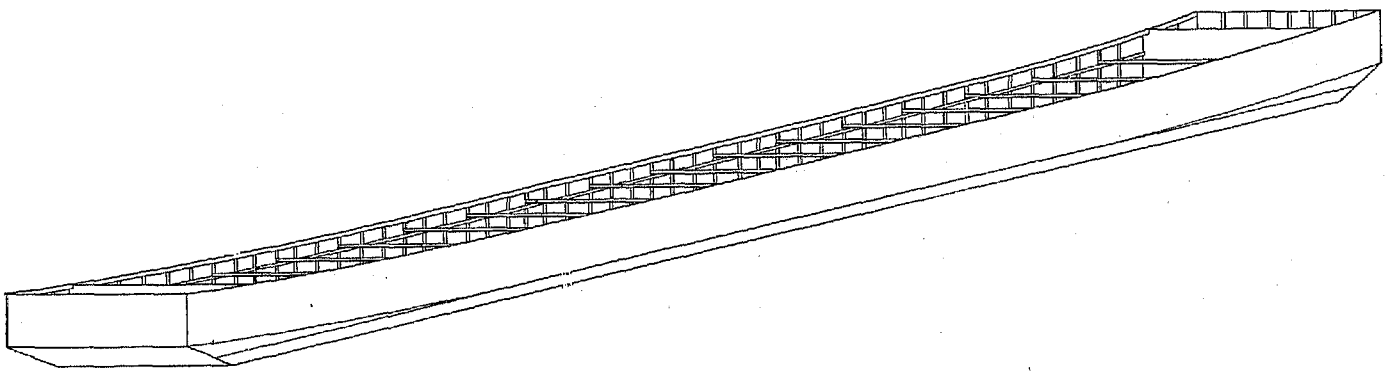


Fig. 55.—Coal boat, or broad-horn.

170 feet long, 25 feet wide, 9½ feet deep on the side; capacity, 950 tons.

one trip at any rate. Two-inch boards are used in boats which are to make several trips. This kind of a top needs to be braced, and accordingly carlines or light beams of 4 by 4 inch hemlock are put in about 8 feet apart, the ends supported by a light clamp, nailed to the studs. A light stringer is nailed to the head of the studs inside for additional strength. Coal boats are built on the Monongahela, upper Ohio, and Great Kanawha. The bottoms are usually built away up in the woods on the small tributaries, where hemlock and hard wood are cheap, and are floated down to the saw-mills below, where they are "sided up", as it is called. Bottoms vary in cost from $300 to $375. With wages at about $2, the labor of "siding up" costs about $95 and the materials $255, and the finished boat sells for from $800 to $900. Although this class of boat has nearly twice the capacity of a barge, it contains no more lumber—only about 35,000 feet in all. It draws only about 4 inches of water light, and stands up so high out of water after discharging cargo that it catches the wind and is hard to handle where the rivers are broad. The raking overhang of the bottom alone makes it possible to tow them up stream.

On the lower Ohio what are called "produce boats" are built from time to time on the same principle as the broad-horns. They are each about 122 feet long, 22 feet wide, and 7 feet deep, and cost from $800 to $900. After carrying a load of produce to New Orleans the boats are sold to the boat brokers for about $200 each, as it would cost nearly $300 to tow them back.

These three classes of barges were originally poled down the rivers or were rowed with sweeps, consisting of long poles with a short board nailed on the end at the proper angle for a paddle blade; for a great many years after the coal trade from the upper Ohio began the cargoes of coal were floated down the river in barges thus propelled. They generally went in pairs, and the crews were divided into watches and labored at the sweeps by turns; but that practice has been entirely discontinued so far as freighting is concerned. A certain number of flats are still owned by private persons, however, who deck and paint the boats, build houses on them, and employ them as traveling tin-shops, blacksmith-shops, and small trading vessels. They visit the bayous and sluggish rivers of the South at regular seasons of the year very much as peddlers travel about in wagons in northern communities, doing odd jobs of work, and are propelled in the old-fashioned way.

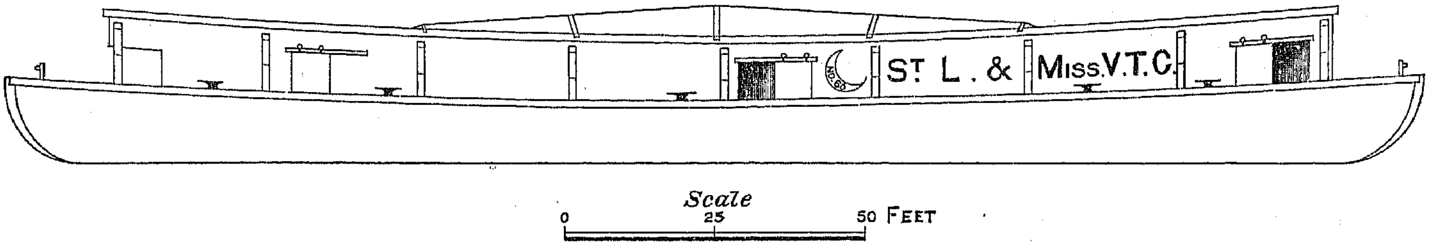
The pride of the western boatman is the model barge (Figs. 56 and 57). When painted, decked, housed, and well modeled these boats excite in a remarkable manner the enthusiasm of the river men, and the clippers of the ocean, with their fine proportions and towering clouds of snow-white canvas, do not stir a Jack Tar to more extravagant eulogy than the model barges receive from the western boatman. There are four sizes of these boats, carrying 600, 800, 1,000, and 1,200 or 1,300 tons of cargo respectively; and to say that the hulls are all modeled with a "pinkie" stern, that is to say, are sharp at both ends, and that they are framed on the same principle as steamboat hulls, is to describe the general points of their construction. Each has, however, only one hog-chain. This is placed in the center line of the boat, hooking under the main keelson at the bow and stern, and supported amidships by four or five pine posts or braces. A light collision bulkhead is built in the bow and also in the stern; when the hold is destined for grain in bulk or package freights it is ceiled up in such manner as to create a great cargo box, with an air-space of about 2 feet between it and the sides of the hull all around. This manner of ceiling up the hold diminishes the register tonnage without affecting the carrying power. The bodies of the boats are straight, the modeled portion of the ends being in length equal to about 1½ the breadth of beam.

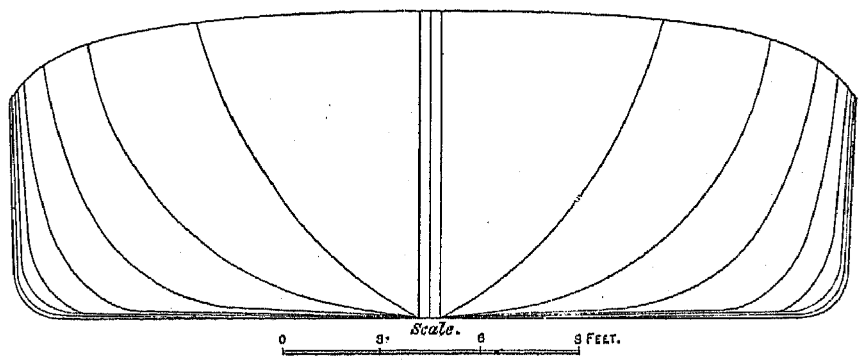
The following are some of the sizes of model barges recently built:

Where built.	Dimensions.			Cargo box.		Register tonnage (tons of 100 cubic feet).	Carrying capacity in net tons.
	Length.	Width.	Depth.	Length.	Height.		
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Pittsburgh, Pa	183	30½	6	147	9	670	560
Do	186	34½	6⅔	153	8½	741	775
Do	186	34½	6½	153	10½	832	775
Do	200	35	7	....	....	899	840
Do	200	36	6½	169	10	908	825
Do	235	38½	7	210	10	1,298	1,200
Freedom, Pa	230	38	6½	200	9½	....	....
Cincinnati, Ohio	225	36	9	210	9½	1,250	1,300
Do	214	35	8	190	9½	975	1,050
Do	175	30	6½	....	....	250	525
Jeffersonville, Ind	220	34⅔	7½	200	10	1,050	1,000
Do	225	36½	7½	210	10	1,248	1,175
Do	226	36½	5⅔	210	10	1,107	1,000
Registered at Saint Louis, Mo., and built at various points on the Ohio.	160	32	6	....	....	215	625
Do	166	32	6	....	....	225	650
Do	180	31½	5⅔	150	10	674	600
Do	183	30½	6	150	10	670	600
Do	183	31	7	150	10	783	675
Do	200	36	7⅔	180	10	1,016	1,000
Do	200	36	8	165	10	996	1,000
Do	200	35½	6½	170	9½	836	850
Do	226	34⅔	8⅘	200	10	1,168	1,250
Do	226	36⅔	6⅔	200	10	1,164	1,100
Do	238	30½	8⅘	210	10	1,237	1,350

The use of model barges is continually growing between the principal trading points on the Ohio and Mississippi. The barges carry iron ore, railroad iron, tile, grain in bulk, and general merchandise. More than 120 are owned in Saint Louis, and are employed for the transportation of grain down the river and of imported iron and other goods back. The barges Monongahela and Allegheny were built at Belle Vernon, on the Monongahela, in 1880, at a cost of $9,000 each. They were 200 feet long, 36 feet beam, and 6½ feet hold, with cargo boxes 169 feet long, 11 feet in height to the top of the roof, and 33 feet wide. Their scantling were: Frames, single, 4 by 8 inches, spaced 14 inches; keel, 4 by 16 inches, laid flat; main keelson, two pieces, 1½ inches apart, so as to receive the heels of the stanchions, 5 by 9½ inches each; bilge keelson, 11 by 6 inches; three light floor keelsons each side; beams, 3½ and 4 inches by 5, the heaviest ones at the hatches, 28 inches apart; nine stanchions, 4 inches square, under every beam, there being about 600 in each boat; three hatches on each side of the main keelson bulkhead. On the floor light planking of 1½-inch pine is laid, with a railroad track and push-car upon it. Planking of the bottom, 4 inches; sides, 3 inches; top streak of sides, 4½ by 11 inches; decking, 2-inch pine. Cargo box, lightly framed and sided up. The hulls had 2 feet sheer, the cargo box 4. The whole boat was of oak, except the beams between the hatches, the bulkheads, floor, deck, and house, which were of pine or poplar. This is a good sample of the scantling of a model barge. The measurements of the keelsons are often varied, but their cross-sections have about the same area in boats of the same size.

One of the new large 1,200-ton barges was as follows: Length, 225 feet; beam, 36 feet; depth, 9½ feet, all oak, except where specified. Frames, 4 by 8 inches on the floor, single; spaced 14 inches in the body of the hull, 12 inches at the bow and stern. Keelsons: main, 6 by 8 inches; six stanchion keelsons, 6 by 6 inches; six intermediate floor keelsons, or footlings, 3 by 6 inches; bilge, 5 by 12 inches. Four clamps, one 3 by 10 inches, the others $2\frac{1}{2}$ by 10 inches. Stringers on the top timbers, $3\frac{1}{2}$ by 6 inches. Poplar stanchions $5\frac{1}{2}$ inches square under every beam on the main keelsons, sided up on each side with 1-inch poplar as a bulkhead. Stanchions on the six large side keelsons under every other beam. Beams, $3\frac{1}{2}$ by 6 inches, in part pine; decking, 2-inch pine. Planking on the bottom, 4 inches; sides, 4, $3\frac{1}{2}$, and $2\frac{1}{2}$, with two upper streaks of 3 inches. Sides of the cargo box, $1\frac{1}{2}$-inch pine. Two heavy breast-hooks and a deck hook at each end, braced. Stem band at each end, 25 feet long, of $3\frac{1}{2}$- by $2\frac{1}{2}$-inch half-round iron, flattened out below and made flush with the planking of the bottom. Hog-chain, $1\frac{3}{4}$-inch iron; a strong plank-sheer of oak, pierced in nine places with strong oak snubbing posts, bolted to the sides below and rising above to within a foot or two of the top of the house to protect it. A strong beam across the boat on top of each pair of posts; about six 10-inch cavils or mooring cleats on each gunwale, and 12-inch bitts in the bow or stern. The barge has two $5\frac{1}{2}$-inch pumps, with 3-inch gas-pipe waste. The weight of hull is about 200 tons. The boat floats light at 12 inches draught, increasing to 16 inches with age, and carries 1,200 tons on 6 feet draught.





Figs. 56 and 57.—Model barge.

235 feet long, 36 feet beam, $9\frac{1}{2}$ feet deep, registering 1,200 tons; carrying capacity, 1,200 tons.

The method of towing barges in the West differs from that of the East. On the Hudson river, Long Island sound, and elsewhere the tug steams ahead of the barges, drawing them with a long cable; but on the western rivers the barges are pushed. They are made up into a group, in files, often eight boats wide and four boats long (Fig. 58), strongly lashed together, and arranged ahead and alongside of the bow of the steamer. About one-fourth of the length of the steamer is buried in the group. The deck is carried out square to the bow, ending in a strong transom or fender for pushing, and, being just two coal barges wide, allows the two central files of the tow to rest their whole weight against the steamer. A fleet thus made up is often 200 feet wide and 640 feet long, counting the tow-boat, and transports from 15,000 to 23,000 tons of coal. To steer such a fleet around the sharp bends of a rapidly running river is a delicate matter, and is accomplished by trusting largely to the current. When nearing

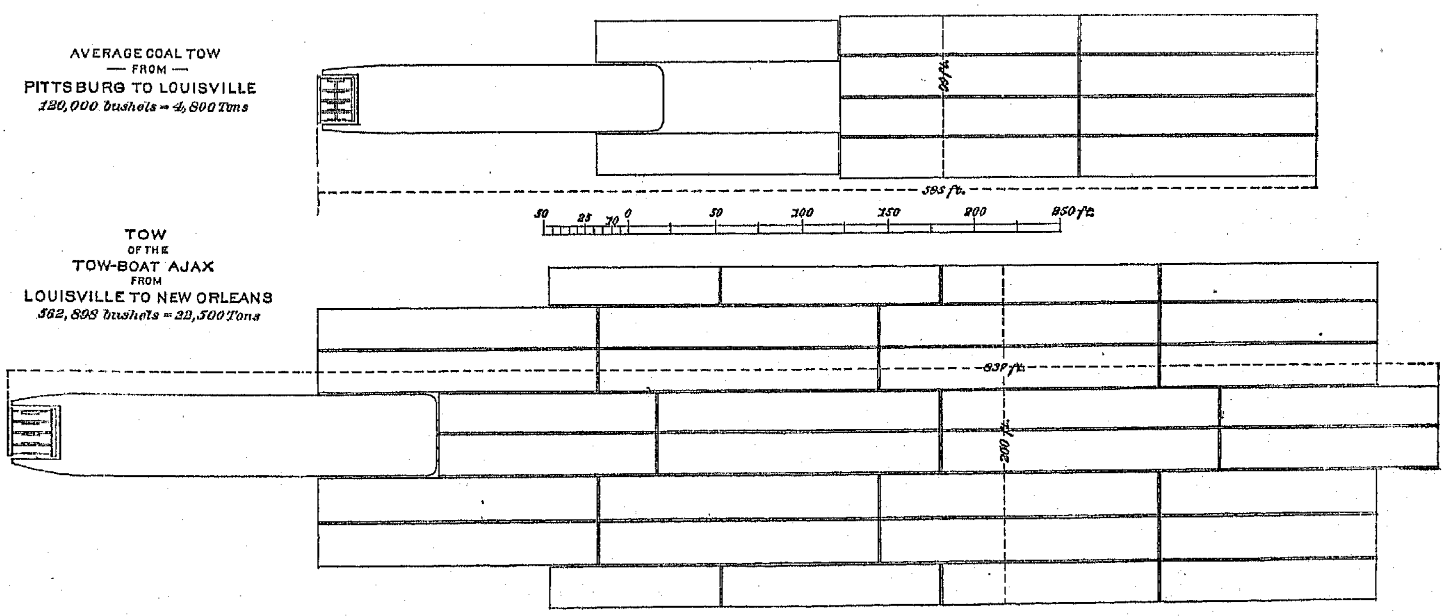


Fig. 58.—Diagrams of coal tows.

a turn in the channel the steamer slackens speed and then begins to back strongly, the object being to check the headway and allow the tow to drift with the stream. The rudders are turned so as to throw the steamer over toward the convex shore, keeping the coal boats in the swiftest and deepest water. The tow floats down half sideways until a clear course opens up ahead, when the wheel is started forward strongly and the tow is pushed straight on again. Owing to the flat bottoms of coal barges it is comparatively easy to handle them in fleets of from 20 to 30. The model barges give the towing captains the most trouble, as they are long and have sharp ends, and five of the larger ones are all that any one cares to pilot down the river and back again.

The principal seat of the barge-building industry is around the head of the Ohio river; that is to say, on the Allegheny, Monongahela, and Great Kanawha rivers, and on the Ohio between Wheeling and Pittsburgh. On the Allegheny the industry is confined to the making of bottoms for coal boats. Hemlock is plentiful at various points all along the stream, and the conversion of the lumber to the purpose stated keeps a great many men busy in a small way in the winter time. The yards are generally in the vicinity of saw-mills. When built, the bottoms are set afloat, loaded with any coarse freight like hay, fire-clay, lumber, etc., that is on hand, and floated down the shallow river to its junction with the Monongahela. They are then towed to the yards in Pittsburgh or on the Monongahela for "siding up". The oak on the Allegheny is worthless, but the pine and hemlock are good.

The Monongahela for 35 miles above Pittsburgh is an active boat-building region, its industry thriving by virtue of the liberal supply of native oak and pine and the existence of an immense coal traffic. The river flows between high wood-covered hills which are full of soft coal, and every mile or two there is a hole in the hillside away above the river, running in often a mile or two, and sometimes away inland into a second range of hills. The coal is quarried underground and brought in small iron cars to the mouth of the mine, whence it is run out on a trestle-work until it is over the water's edge and dumped into chutes running down to within a few feet of the surface of the river. The flats, barges, and broad-horns lying in the stream are brought underneath, loaded with coal, and then moved aside and moored in large fleets, awaiting the months of deep water. The coal trade is active three times a year. Six or eight feet of water in the river bring a swarm of tow-boats up from Pittsburgh. Each steamer takes as many barges as it can handle down stream to Pittsburgh, Wheeling, Ironton, Cincinnati, and all the lower markets, the fleets intended for points on the Mississippi being doubled up after passing the canal at Louisville. Business is done with a rush in times of deep water, and a million tons of coal will often go out of the Monongahela in four weeks' time after a rise of water.

VESSEL-BUILDING LOCALITIES.—There are 31 boat and barge yards on the Monongahela, but such a large part of their product is destroyed every year by being broken up, by wreck, and by natural decay, that the yards are continually at work.

At Rice's landing, about 35 miles from Pittsburgh, coal-boat bottoms are made and barges built, about 20 or 30 of the latter every year. The bottoms are made from hard wood, at a cost of about $300.

At Brownsville there are three yards, two on one side of the river devoted to siding up coal boats with pine and hemlock, and the third, on the other side of the river, an old yard, where the smaller class of steamboats are built in considerable number. Almost without exception the boat-builders of the Monongahela have each a saw-mill in their yards, and the three at Brownsville are not exceptions. At the steamboat yard the mill is employed in general business to some extent, but its main use is to manufacture material for the boats. The oak comes down the river in rafts from points in West Virginia, and costs from $10 to $14 a thousand feet in the rough log, while the pine and hemlock come principally in the round log from the Allegheny river. While enjoying cheap timber, the Brownsville men labor under the disadvantage of having several dams across the river below them. Of steamboats, therefore, they can make nothing except the hulls for the medium class of boats, for they have to send them down over the dams. Hulls 250 feet long have to be built below the dams, and the majority at Brownsville do not exceed 180 feet in length. They cost from $2,000 to $4,000 each, one-third of which is for labor, and there are from 50,000 to 150,000 feet of lumber consumed in making each hull. Tow-boats are of heavier scantling, and, for their size, consume more material. The main yard at Brownsville built 10 hulls and many coal boats in the census year. Wages were low, ranging from $1 25 to $2 25 per day, but nearer Pittsburgh they were 50 cents or more higher. The coal boats at Brownsville were each 170 feet long, 26 feet broad, and 9 feet deep, costing $900.

At Greenfield 15 or 20 flats and about 25 broad-horns are built yearly. The size of flat in the census year was 90 feet long, 16 feet broad, and 5½ feet deep. Each cost $600, of which $100 was for labor. Hemlock and oak were the woods used.

California, below Greenfield, formerly had a yard or two.

At Belle Vernon there is a yard whose owners have built more than 40 model barges and numerous steamboat hulls. Oak costs from $13 to $15 a thousand feet in the squared log at this point. Three hulls and 2 model barges were built in the census year. The hull of the Plow Boy, 150 feet long, 28½ beam, and 3 feet hold, cost $2,000, while those of the Dacotah and the Montana, stern-wheelers, 252 feet long, 48⅝ feet beam, 5½ feet deep, and register capacity of the hull 575 tons, cost $8,000 each. A model barge 200 feet long, with deck-houses, costs $9,000. These river boat yards used few heavy pieces of machinery, as the scantling of the boats is light. Bevel saws are not required, nor are bolt-cutters required to any extent.

At Monongahela City there are two yards, one of them devoted chiefly to repair work. At the main yard a large saw-mill is employed, and an active business is done in building and siding up coal barges and boats for the mines in the vicinity. The barges are 130 feet long. The repair yard is provided with a marine railway having five tracks, and vessels are taken out sideways, this being the fashion in the West. The windlass is worked by hand-power. Repairs consist of calking and carpentry work.

Three yards at Elizabeth are devoted to work for the coal trade. From 60 to 80 barges and flats are built yearly. A larger number of broad-horns are sided up; sometimes more than 150 bottoms are bought on the Allegheny. One firm had contracts out for 100 bottoms in the census year, to cost from $350 to $400 each, and in each of the yards a master carpenter was employed to build and side the boats for a certain sum per vessel, materials being supplied. This is a common practice on the Monongahela, where the yards are frequently owned, as at Elizabeth, by coal dealers. Contract prices for labor vary with the times. The following facts were obtained:

Flats.—Value of the boats in 1880, $500 to $690; labor, $90; lumber in each boat, 20,000 feet; iron, about 2,000 pounds.

Barges.—Value, from $1,000 to $1,300; labor, from $155 to $195; lumber in each boat, 34,000 feet; iron, 2 tons.

Coal boats (165 feet long, 28 feet beam, 8¼ feet deep).—Bottoms, from $350 to $400; cost of docking and calking, each $70; siding up, $350, of which $95 was for labor; lumber in the top, 9,000 feet; iron, 750 pounds.

One of the Elizabeth concerns was busy in 1880 with a government contract, and it was building for the Mississippi river improvement commission two decked barges 211 feet long, 35 feet wide, and 5 feet deep, two of the same size but only 25 feet wide, and ten 100 feet long, 25 feet wide, and 5 feet deep. Near Elizabeth three small sectional dry-docks were stationed for repairing.

At Dravosburg a coal firm builds its own boats, consisting largely of strong barges, each 130 feet long, 25 feet wide, and 7½ feet deep, with six gunwales on a side, made of white pine, with the exception of the streamers and bitts. One consumes 31,000 feet of white pine, 3,500 feet of oak, and 2 tons of iron, the cost being about $1,000.

A few miles below this place is a new yard. Very little work was done in the census year, but some 135-foot barges were building in 1881, and four small sectional docks were employed in repairing.

At McKeesport, a manufacturing town, there are four yards, two of them devoted to repair work, the others to coal-boat building.

A large saw-mill is located at Six-Mile Ferry, at which from 50 to 75 coal barges of different classes are produced yearly. At this yard some barges of unusual size have been built. Each is 160 feet long, 24 feet wide, and 8 feet deep, consuming 36,000 feet of lumber, and cost $1,200 each, $265 of it for labor.

In Clare township, just above Pittsburgh and below the place last named, there are three yards which come under the influence of the high wages of the city. They were paying $2, $2 50, and $3 50 a day in 1881, and at one of them a mixed business of repairing and building was carried on. The proprietors said that work was leaving them for places further up the river, and for Freedom and Sewickley, below Pittsburgh.

Within the limits of Pittsburgh and Allegheny City there are three firms which build and side up boats, three firms which thrive by cabin building, one firm which is now building steel hulls for river vessels, and several firms which make engines and boilers. The joiner work of the cabins is generally ¼-inch white pine or poplar. About 45,000 superficial feet are required for the cabins of a steamer of moderate size, and about 95,000 for those of a 250-foot boat. Altogether on the two rivers there are built every year about 600 completed barges and hulls, employing an average of 420 men at steady work.

At Freedom, Pennsylvania, there is one yard, long established, where for 30 years river steamers of all sizes used on the upper Ohio have been built. Here were built the fast packets that ran to Cincinnati. One boat, the Messenger No. 2, 250 feet long and 60 feet beam, once made a famous trip from Cincinnati to Pittsburgh. She was stripped for the race, and "carried only her machinery and Jenny Lind". The voyage was usually made in 30 hours, but this time it was accomplished in 18. The proprietors submitted for inspection a great mass of specifications and contracts for hulls, almost all for stern-wheelers. One of them was for a 290-foot side-wheel boat, several were for 250-foot, and the rest for from 100- to 235-foot stern-wheel boats. The building price has been from $30 to $35 per register ton for strong-built hulls. The cabins and machinery are put in at Pittsburgh, where the vessels are usually owned. The lumber used at Freedom is white oak and poplar from the upper part of the Monongahela and white pine. The poplar comes down with the oak, being incorporated in the rafts as floats. The wood is light and durable, and is the best material for fore-and-aft bulkheads, cabins, etc. Oak costs in the log from $13 to $15 and pine about $10 per thousand feet, and the yard saws its own lumber. It was stated here that oak wastes extremely in working up, owing to the large quantity of defective pieces. A worm hole, a shake, or a stain in the wood causes its instant rejection, as no vessel owner will accept a stick or a plank having the slightest flaw. Were it not for this fact, nearly every cubic foot in the logs after they are squared could be used, for these western boats require little crooked timber in the frames and almost none anywhere else. The bilge is turned with flitch knees, nailed to the side of the frames, and only in the extreme bow and stern are crooked frame timbers used. The hulls of seven steamboats were built at Freedom in the census year, at a cost of from $30 to $35 per register ton of capacity. Two towing-boats were each 177 feet long, and one was 132 feet long. The Harry Brown, a towing-boat of 772 tons, was 210 feet long, 49½ feet beam, and 6 feet deep, and has proved to be a powerful boat. Her total cost was about $75,000, the machinery costing $22,000. One of the new boats was the passenger steamer Carrier, 250 feet long, 40 feet beam, and 5½ feet hold, registering 815 tons, built for the Missouri river trade. About 35 men find steady occupation at this yard.

At Sewickley, Pennsylvania, there is one yard, a new one, which, like the one at Freedom, is devoted entirely to steamboat and model-barge work. It has its saw-mill, bevel saw, and general outfit of tools. Four steamers were in course of construction when the yard was visited in the census year, of which two were afloat and two on the ways, all stern-wheelers. In 1881 the river was so low that there was not over 3 inches of water on the sand-bars above, and as at least 3 feet of water were required in order to send the hulls up to Pittsburgh the proprietors were compelled to put the tops of the new boats on at Sewickley, the joiners going down from the city every day for that purpose. The new boats were all for towing (Fig. 59), and were accordingly strongly framed. The two on the stocks were 192 feet long, 35 feet beam, 34 feet wide on the floor amidships, and were molded 6 feet deep. One of those afloat was 200 feet long, $38\frac{7}{12}$ feet beam, 46 feet wide over all, 6 feet deep, with 38 inches sheer forward and 18 inches aft. A description of this boat will show about how the towing steamers are made. Frames: floors single, 4 by $7\frac{1}{2}$ inches, extending from bilge to bilge in the square body; in the bow and molded part of the stern the floor reaches only half across the boat, and there are futtocks abutting over the keel; top timbers, 4 by $6\frac{1}{2}$ inches; spacing 13 inches. Stem sided 11 inches, molded about 30 inches in the thickest part; no apron, but a sort of stemson. Two stern-posts 11 inches thick. Keelsons: main, 7 by 18 inches; one wing keelson each side, 5 by 14 inches; two floor streaks each side, 3 by 8; bilge keelson, 5 by 10. Two clamps, 3 by 12, and $2\frac{1}{2}$ by 12 inches. No ceiling. Beams, 4 by 7 inches, with 9 inches spring; aft, $3\frac{1}{2}$ by 7. Head piece at bow, 8 by 16 inches, being 46 feet long. Stanchions on main keelson, 3 by 4 inches, sided up with 2-inch poplar to form a double bulkhead. Stanchions on wing keelsons, $3\frac{1}{2}$ by 4 inches, sided up with $2\frac{1}{2}$-inch poplar, forming a single bulkhead. Stanchions, 4 inches square on each floor streak. Plank of bottom, 4 inches; grub streak on the bilge, 5 inches; sides $3\frac{1}{2}$, tapering to 3 inches. Short flitch knees or futtocks at the bilge. The bilge secured at each frame by bolts of $\frac{1}{2}$-inch iron, driven clear through the streak of bilge planking, the frame timber, and the bilge keelson. Decking, $2\frac{1}{2}$-inch white pine. Top plank-sheer, 3 by 14 inches; under one, 2 by 12 inches; nosing, $3\frac{1}{2}$ by 11 inches. Cylinder timbers, oak, sided 13 inches, 4 feet deep in the thickest place. Heel pieces on the floors for the main hog-chain braces, each side, 13 by 22 inches. Four main hog-chain braces on each side of the boat from 42 to 46 feet long, white pine, 13 inches square below, 11 inches above, carrying on their top a $1\frac{3}{4}$ bar-iron rod, or, as they call it in the West, a chain, which descends at the ends to the keelson and supports the ends of the boat. In line with these braces is another set, called relief braces, 8 inches square, carrying a $1\frac{1}{4}$ chain, which supports the hull at different points from the others. On the main keelson there is a row of posts, or braces, 11 inches square, over which runs the main center chain of 2-inch iron, descending to the main keelson at each end. The bilges are supported by 8 thwartship $1\frac{1}{2}$-inch chains, supported by as many sets of light braces. The weight of the boilers and of the wheel is supported by other sets of chains and braces. Four rudders with 14-foot blades, the middle two to have 9-foot balance blades; rudder stocks 17 inches square. Stem band, $3\frac{1}{2}$-inch half-round iron for 9 feet; the rest of the way of flat iron 1 by 6 inches. Calking of bottom, 5 threads; of sides, 3 or 4; the oakum to be driven through flush with the inside of the plank, this being the universal practice in the West. Two spars, to stand on the forward deck at the fore edge of the upper works, 14 inches in diameter, 38 feet long. Two derricks, 9 inches in diameter, 34 feet long, and four 6 inches by 20 feet. Six boilers, each 47 inches in diameter and 28 feet long, having 6 flues 10 inches in diameter. Boilers set 40 feet from the bow. Chimneys, rising to 54 feet from the deck, 58 inches in diameter. Two engines, each $24\frac{1}{2}$ inches in diameter, 12 feet stroke, set 34 feet from the stern. Wheel, 28 feet in diameter; buckets, 28 feet long and 3 feet wide. Launching draught of hull, 20 inches aft and 24 inches forward; with machinery, water, and 285 tons of coal aboard, 42 inches even draught, the displacement being 785 tons.

There were seven steamers built at Sewickley in the census year, all towing and freight boats, the most of them stern-wheelers. One, the Florida, was a side-wheeler, 180 feet long, destined for coast service. The cost of the hull was from \$30 to \$35 per register ton. One tow-boat was 122 feet long; the others ranged from 180 to 260 feet, consuming from 100,000 to 225,000 feet of oak, pine, and poplar. The yard gives employment to 65 men in busy times at \$1 25 a day for laborers and \$2 25 for good carpenters.

Freedom and Sewickley are now the main dependence of Pittsburgh for her steamboats, as are the two rivers above the city for her coal barges. The whole tonnage of the city has to be renewed every six or seven years; as Pittsburgh owns the most of any port in the Union, the basis exists for a prosperous business. An effort is now being made to extend the use of iron hulls for steamers. During the last fifteen years the district about Pittsburgh has produced 340 steamers.

At Steubenville, Ohio, there is a small yard, where much work is done in busy years.

Wheeling, West Virginia, once did a flourishing business in making steamers and the machinery for them, and from 5 to 10 vessels were launched every year, as well as many barges. The principal firm owned a tract of 1,500 acres of timber in Marshall county, the trees of which they cleared off and put into boats. They built a class of vessels adapted for the small rivers and bayous of the South, both side- and stern-wheel, but when the war broke out lost heavily from inability to collect what was due. The industry in Wheeling was greatly affected by the war, and of late the yards have done nothing except to make a few barges from time to time. Two firms of joiners do a little business, however, in putting cabins on boats built at various points in that region on the Ohio and on the West Virginia streams, and one firm builds machinery for the same boats, from eight to ten boats a year being so fitted out.

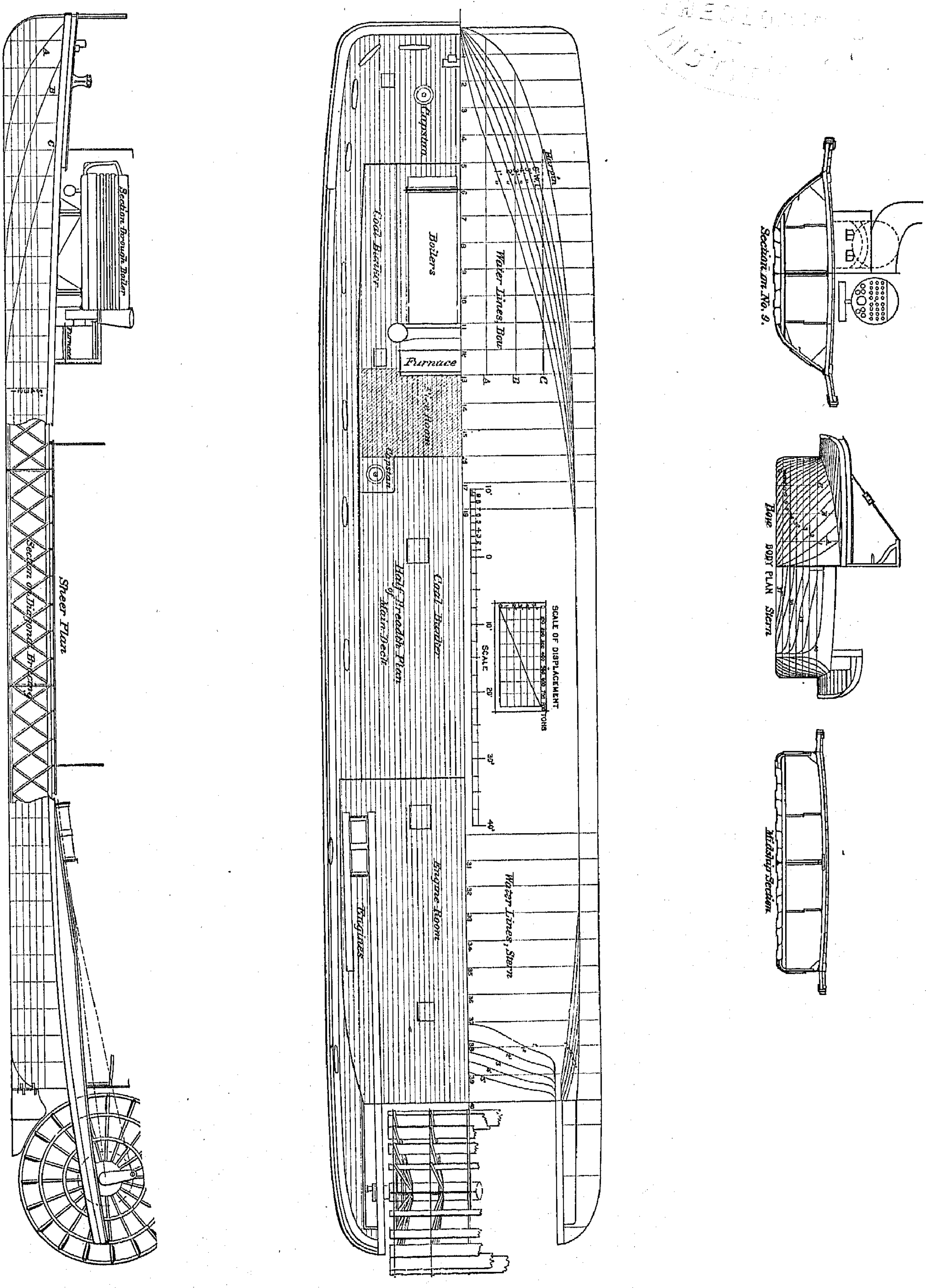


Fig. 59.—WESTERN RIVER TOWING BOAT.

This illustration is a good representation of the model of the stern-wheel steamboat of the West. The plan is intended for an iron hull.

A rising coal trade on the Great Kanawha river calls for local barge building, its commencement appearing at a number of points. From 30 to 50 boat bottoms are made on the Elk river every year, and are floated down to Charleston on the main stream and there sided up. At Coalburg, up the Kanawha, from 10 to 20 barges are built yearly by the coal company, and a dozen or more are made at Charleston. There is an abundance of timber in this region, and time will bring the capital and the enterprise; but saw-mills and railroads are needed. The one yard at Charleston could have built 100 barges in the census year if the lumber had been obtainable. Owing to low water in the river pine could not be brought in, and a lumber famine often occurs, during which oak will rise to $25 per thousand feet. The barges built at Charleston range from 100 feet in length, 18 feet beam, and 5 feet depth, to 130 feet in length, 24 feet beam, and 7 feet in depth. A little steamboat work is done here, and there is a float for repairing. Coal-boat bottoms cost from $150 to $250 at Charleston; the labor of siding up costs $45, and the boats, when finished, were worth $450. Wages were from $1 25 to $1 75 a day. The Kanawha is already one dependence of the cities on the Ohio for coal, every flood bringing out of the river a considerable rush of steamers and barges.

The points where small work is done in West Virginia are Point Pleasant, Murrayville, and Mason City; they enjoy the advantage of abundant timber.

A little yard at Marietta, Ohio, employs about 35 men in building small steamers. There is another at Ironton, Ohio, on the side of a steep bank, where many vessels have been launched, including more than 25 model barges; also a yard at Portsmouth, Ohio. At Middleport there is a dry-dock for repairing, and a small yard at Ashland, Kentucky, builds ferry and passenger boats and does repair work.

Cincinnati has two large yards. The Marine Railway and Dry Dock Company's yard is one of the largest and best equipped in the West, and has its own saw-mill and a complete outfit of machinery and tools, lumber being bought in rafts, hauled up on the bank by steam-power, and sawed to suit the vessels under construction. Few concerns in any part of the United States, excepting only the iron-ship builders, keep so elaborate a set of books as this company. A faithful account being kept of every foot of lumber of the various kinds, of every pound of iron, paint, and oakum, of the days of labor, and of every other detail of the cost of the several boats and jobs of repairing, the exact cost of each vessel is thus ascertained, and the various items tabulated for future reference. This process enables the firm to bid accurately and successfully for contracts. Bookkeeping is not as a rule minutely carried on by the ship-builders of the United States, and in a large number of yards the accounts are kept roughly, often on loose sheets of paper or in little pocket note-books, and sometimes on shingles. More than one large yard was visited (not on the Ohio river) where the proprietors did not know what a vessel had actually cost them when finished, the data about the various jobs of work not being thoroughly sifted out and kept apart. At the Cincinnati yard thorough system was observed, at no appreciable increase of running expense; and the facts obtained about river vessels in general were of the most satisfactory character. Seven steamers and three model barges were built by the Marine Railway and Dry Dock Company in the census year, viz:

	Tonnage.	Length.	Beam.	Width of floor amidships.	Depth of hold.	Cargo-carrying power.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Tons.*
Side-wheeler Natchez	1,477	303½	46½	38½	10	2,000
Stern-wheeler Granite State	531	223	35½	34½	5⅓	800
Side-wheeler Bostona	993	302½	43½	42	10	1,000
Stern-wheeler Will Kyle	1,017	260½	45⅔	43⅔	6⅓	1,350
Stern-wheeler Hettie	176					
Stern-wheeler Pittsburgh	722	252	39	38	6	900
Stern-wheeler Clifton	716	152	39	37	6	900
Model barges 3 in number	236	160	28	27	5½	350
	270	180	32	31	6½	650
	270	180	32	31	6½	650

Although dependent on the tributaries of the upper Ohio for oak and poplar, and always embarrassed when the rivers are so low as to prohibit the rafting of logs, the Cincinnati yards are able to build as cheaply as their competitors up stream, hulls being made for from $20 to $30 per register ton. In Cincinnati, as in Pittsburgh and Wheeling, cabin building is a separate occupation; the contract is usually sublet to some joiner, who owns a large saw-mill and manufactures his own lumber. Poplar, the cheapest and best wood for cabins, is extensively used, and ranges in price from $16 to $30, but is usually nearer to $20 per thousand feet when finished. Oak, white pine, and poplar are the building woods. As a novelty, yellow pine and cypress from the South were put into the beams of the Natchez. This boat was sharp built and intended for speed. She was strongly framed, her floors being 4 by 11 inches square amidships and 5 and 6 by 11 forward, spaced 14 and 15 inches. Her main keelson was 9 by 18 inches, bilge 8 by 14 inches, ten floor streaks 6 by 10 inches, and stringers 3 and 3½ by 12 inches; clamps 3, 3½, and 4 by 40 inches. The central bulkhead of this boat was made of 5-inch poplar, edge-bolted with ½-inch iron 3 feet apart. The waste of wood in making these boats is nearly one-half. The Natchez consumed 390,000 feet of oak, 120,000 feet of pine and poplar, and 29,000 pounds of iron in the hull, and 200,000 feet of wood in her cabins. Her machinery weighed 200 tons, the cylinders being 34 inches, with 10-foot stroke. She was a strong, fast, handsome side-wheel boat, with broad guards for cotton carrying.

The other yard at Cincinnati made 3 steamboats, 4 model barges, and a wharf-boat in the census year. The barges were for the grain trade of the Mississippi. Contracts for more than 20 of those boats had been given out in the census year, distributed all along the Ohio. They were of two sizes: 200 feet long, 35 feet beam, and 8 feet hold, and 225 feet long, 36 feet beam, 9 feet hold, all with cargo boxes, and carrying about 50,000 bushels of grain. The cost of the barges was $9,000 and $10,000 each, according to size.

A yard at Covington, Kentucky, thrives chiefly by repair work. The shops are located on the high bank of the river, out of the reach of ordinary floods, and the vessels are drawn out by steam-power, sideways, upon the railway. A few small steamboats and 15 or 20 coal barges are produced in good years.

In Indiana there are large yards at Madison, Jeffersonville, and New Albany, all old building places. Four or five steamers and a few barges are launched yearly at Madison, and repair work is there done on a large set of ways.

Jeffersonville has two large and flourishing yards. It is remarkable that on the Ohio the yards are located chiefly on the northern bank. Those at Jeffersonville employ jointly about 400 men in good years, the majority of them men with families, who are prosperous. At least as early as 1819 boats were built here out of the oak that clothed the region in dense forests. The side-wheeler United States, of 700 tons, was launched in 1819 and sent to New Orleans to receive her machinery, which was imported from England and was modeled after that put into Fulton's steam frigate, then lately built at New York. The popular boats of that day were smaller than 700 tons, but quite a number of them were required, from five to ten being launched in this vicinity every year. The war of 1861 interrupted the business; but since that time it has grown to larger proportions than ever, and in no locality in the West have there been more large and famous boats built than at Jeffersonville and around the falls of the Ohio, a mile or two below. In 1866 the owner of the older yard put in a planer for fairing the planking, beams, etc. All the lumber of these western boats is planed. The diminish in the thickness of the plank at various points in the hull is put in by means of the planer, and the success of this machine led to its general adoption in the boat-yards of the West. In the census year the product of this yard was 12 model barges, several flats, and 6 steamboats. Eight of the barges were for the Mississippi Valley Transportation Company for grain carrying, and registered from 1,150 to 1,250 tons, being 200- and 225-foot boats, with cargo boxes. A little repair work is done. The bottoms of the freight boats here are given 3 or 4 inches of dead rise only; the passenger boats about 14 inches.

The other establishment at Jeffersonville was started in 1834, since which time it had built 318 steamboats up to the census year of 1879–'80, mostly stern-wheelers, but also including a great many of the fast and famous side-wheelers in the trade to New Orleans. Among their recent boats have been the J. M. White, the Ed. Richardson, the City of Baton Rouge, the City of New Orleans, City of Yazoo, Rainbow, and Jesse K. Bell. In the census year the product of this yard was eight steamboats, a two-wheeled propeller tug-boat, a barge, and a wharf-boat, besides considerable repair work. The barge was the Victor, of 168 tons, 115 feet long, 27 feet beam, and 7½ feet depth of hold. This boat was strongly built, and was sent to Galveston, where she was rigged as a two-masted schooner for shoal-water service, in which employment she has done very well. In waters where there is no current schooners of this class can successfully be employed. The model is in reality about the same as that of the Chesapeake bay bug-eyes, flat floored, sharp at both ends, with slightly hollow water-lines below; the broad beam fits it for a fore-and-aft rig. The tug-boat above referred to was the Wash. Gray, of 46 tons. She had a bow, deck plan, and house like an eastern harbor tug, but was modeled amidships and aft like a western boat, except that the floor was narrower. Her dimensions were: Length, 78 feet; beam, 18 feet; floor, 10 feet; hold, 6½ feet. This little boat, with her machinery, etc., weighs 110 net tons and floats at 7 feet draught. She is oak built with single frames, with short futtocks added at the bilge. The keelson is 7 by 12 inches square; side keelsons, 3½ by 9 inches. There are two fire-box boilers 64 inches in diameter and 14 feet long, and two double high-pressure engines 12 inches in diameter and 14-inch stroke. The screw wheels are 5½ feet in diameter, each weighing 3,300 pounds. This boat was well suited for harbor use, and was the first of her class seen on the Ohio, although it was not the first propeller. A few small propellers used here and there farther up the stream are supplied with wheels from Chillicothe, Ohio. At Saint Louis the propeller tug is a popular boat.

The oak for the Jeffersonville yards now comes from West Virginia, 550 miles away, as the local supply is very nearly exhausted. A little first-growth timber, large and fine, remains in the swamps of the river counties, and is sought for cylinder timbers; but the most of it stands so far away from the streams and railroads as to be practically inaccessible.

In Louisville little is done except occasional jobs of cabin building and the making of machinery and boilers, in which there is a flourishing business. One of the new boats from Jeffersonville lay alongshore in the fall of 1881 receiving her outfit, namely, the City of New Orleans, 300 feet long, 48 feet beam, 83 feet wide over the guards, and 9 feet hold. She was just one foot too wide to go through the canal, and the intention was to take her down the rapids, like many of her predecessors, when the water should be deep enough. Her draught with

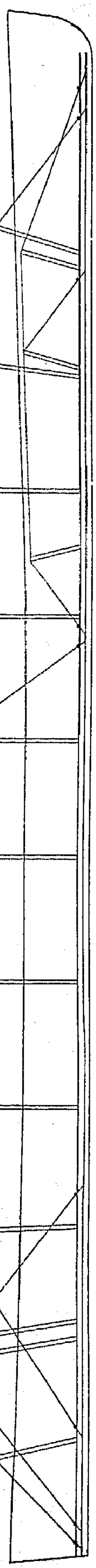


Fig. 60.—Hog-chains of the City of New Orleans.

Main chain, $2\frac{1}{2}$-inch bar iron, sustained on pine braces 9 inches square, rising about 14 feet above the deck, or to just under the beams of the cabin deck. Center chain, $1\frac{3}{4}$-inch bar iron, the forward end descending to the main keelson just under the after end of the boilers, the chain running back over the main braces and descending to the keelson again, about 15 feet from the stern-post. Stern chain, $1\frac{1}{2}$-inch iron, sustained by one brace. Boiler deck and bow chain, $1\frac{1}{2}$-inch iron, the braces rising to just under the deck beams.

machinery, coal, and water aboard was 42 inches aft and 30 inches forward. Her scantling were: Frames, single, 9 by 4 inches, spaced 15 inches; main keelson, 21 by 9 inches; eight floor keelsons, 9 by 4 inches; four wing keelsons, 7 by 12 inches, to receive the heels of stanchions and hog-chain braces; bilge keelson, 6 by 12 inches; planking, 4 inches on the bottom, 4, $3\frac{1}{2}$, and 3 inches on the sides. Beams, 4 by 6 inches, spaced 21 inches; heavy beams, 12 by 12 inches at the end of the boiler deck. Stanchions, every other beam, 6 inches square, there being seven rows of them fore and aft, with about 30 extra oak stanchions, 10 by $3\frac{1}{2}$ inches, under the cylinder timbers and paddle-wheel shaft. There were three stringers on the top timbers, each side, 9 by $2\frac{1}{2}$ inches. Clamps, 13 by $3\frac{1}{2}$ inches, and 12 by 3. As in all western boats, the boilers, five in number, were on the deck of the hull forward, each 30 feet long, 44 inches in diameter, with four flues, and were made of steel. Engines, one on each side, amidships, 26 inches in diameter, 10 feet stroke; wheels, 35 feet in diameter, with 15-foot paddles. While the hull sat low in the water, the cabins towered aloft to a height of 38 feet to the roof of the main cabin and $67\frac{1}{2}$ feet to the top of the pilot-house. The halls of the main cabin were 220 feet long, 17 feet wide, and 13 feet high. The state-rooms, forty-five in number, were each 12 feet long by 10 feet wide, and were furnished in hotel style. This boat was intended for the passenger and cotton trade of the Mississippi. Her capacity was 250 passengers and 2,300 tons of freight on about 9 feet draught. Builders say that the greatest trouble they have in producing this class of boat is to hold up the sterns, bows, bilges, and guards, as well as to give proper support to the hull when it feels the weight of the boilers, and an elaborate system of hog-chains and braces is required. The fore-and-aft arrangement of the City of New Orleans was as follows (Fig. 60):

Forward of the wheel-houses there are thirteen cross-chains of $1\frac{1}{2}$-inch iron, with braces 6 inches square heeling on the plank-sheer, as in the illustration on page 193 (Fig. 61), supporting the guard. The wheel-houses are supported by two chains of 2-inch iron at each end, running across the boat; braces, $9\frac{1}{2}$ inches square. Aft of the houses are five cross-chains of $1\frac{1}{4}$-inch iron to support the guards, braces heeling on the plank-sheer.

There are also seven cross-chains of $1\frac{1}{2}$-inch iron on the engine deck, sustained by seven of the main braces, with struts as in the illustration, the chains giving lateral support to the bilge of the boat. Under the boiler deck and forward are located nine other cross-chains of $1\frac{1}{4}$-inch iron, performing the same service. The total weight of wrought-iron consumed in this light and admirable system of chains was 48,000 pounds. By means of this system the guards were enabled to carry all the cotton bales that could be stowed upon them, the hull was kept from sagging or breaking down in any direction, and it was possible to give the whole boat the light scantling peculiar to the West. Were the same strength gained by heavier timbers, the boat would have weighed two or three hundred tons more. The New Orleans and the Baton Rouge have proved to be fast boats, the latter having run from New Orleans to Saint Louis, loaded, in 4 days 14 hours and 25 minutes, making fourteen stops.

New Albany, below the rapids, has a large yard, owned by a Saint Louis firm, and one other, at which several model barges were built in the census year; but since the completion of the canal to its full width the active business of New Albany has been transferred to the yards above the falls.

Evansville, Indiana, enjoys the advantage of abundant oak timber, and the finished lumber is said to cost no more here than the squared logs do at Jeffersonville and points above. Oak grows plentifully in this part of Indiana, but is cut close to the railroads and the main streams. Back in the country the growth is heavy and large, and a great deal of it is now cut for shipment by car and boat to other points. The builders can also draw on the rivers of Kentucky for ample supplies. Oak is cheaper at Evansville than white pine, and as a consequence many coal barges and flats are either built wholly of oak or bottomed with oak and finished with white pine, the pine timber having latterly been brought from Chicago by rail. While there are no regular boat-yards at Evansville, there are several master carpenters who build small steamboats, coal barges, and flats, as they are required, going down to the foot of the river bank and constructing their vessels there. A coal firm has a small set of ways on which repairing is done, and there is work enough to keep 15 or 20 men pretty busy; but nearly all have other trades to fall back upon when boat work is dull. A saw-mill boat was being finished in 1881 when the place was visited, and there were several barges on the bank. The saw-mill boat h a flat-boat hull, square on deck at both ends, with raking bow and stern. Her dimensions were: Length, 114 feet; width of hull, 22 feet; width on deck, 32 feet; depth of hold, 4 feet. A roof or upper deck was built over the deck of the hull, supported by light stanchions, the sides below being entirely open. On the upper deck were small cabins for the crew and a pilot-house. There were two boilers under the forward end of the sheltering roof 45 inches in diameter and 14 feet long, carrying 80 pounds of steam, and having about 40-horse power. There was a light engine aft to drive the paddle-wheel at the stern. The rest of the deck was taken up with saw-mill machinery, so arranged that logs could be hauled up over the bow of the boat, run aft, sawed, and discharged over the side amidships upon barges, each carrying from 150,000 to 200,000 feet of lumber. There were eight or nine of this class of boats in the South. They go about in the rivers and bayous and saw for the New Orleans and other markets, and their cost complete is from $8,000 to $11,000 each. A number of traveling flat-boats, housed over for blacksmith and other shop work, lay in the river at Evansville. These boats were all fitted out with four or five long sweeps, and displayed hen-coops, clothes-lines, and all the paraphernalia of the simple housekeeping of the occupants.

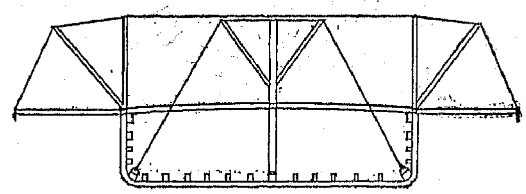


Fig. 61.—Cross-chains on the City of New Orleans.

At Evansville there are registered every year a number of small vessels built on the streams of Indiana, Illinois, and Kentucky. These vessels are not the product of regular ship-yards, but are made by men who are employed by the owner for the special job, just as a carpenter is employed to build a house. These boats are intended for local service, generally for river ferries, and do not require much knowledge of ship-building, and their construction is a small incident in the industries of their several localities. The places where boats have been latterly built at odd times are Pageville, Frankfort, and Caseyville, Kentucky; Shoals, La Fayette, Vevay, and Bridgeport, Indiana; Peoria, Grafton, Washington, and Newburg, Illinois.

Metropolis and Mound City, Illinois, on the Ohio, each has a ship-yard where barges and steamboats are built. At the latter place there are large marine ways. At Cairo there is always a large amount of tonnage loading and unloading, but only one small yard, which is devoted to the repair work of the Cairo City Coal Company. At Paducah, Kentucky, there are large and flourishing marine railways.

The western marine railways are unique. They have to be wide enough to take out vessels sideways, and are furnished with a sufficient number of tracks and cradles running on them to support the vessels at every point in their length. The Mound City ways, for instance, have 8 sets of tracks, each about 8 feet wide and 30 feet apart, so as to make the entire width of the railway about 275 feet; the pitch down the bank is nearly 2 inches to the foot. Each track carries a low car, or cradle. A broad, flat platform is built at the top of the bank, and an array of eight powerful iron windlasses, worked by a line of shafting laid along the surface of the ground, is set up under the fore edge of the platform. The slope to the river is 160 feet long in low water. The cradles, each held by two $1\frac{3}{4}$-inch chains, are allowed to run down the ways into deep water until they are under the boat which is to be hauled out, the windlasses are set in motion, the chains coil around the drums, and the cradles come up the bank slowly, the boat settling down upon them gradually. The windlasses each consist of a horizontal iron drum 30 inches in diameter, with a large cogged wheel at each end 7 feet in diameter. Power is communicated from the 6-inch main driving shaft to each end of the windlass by a cogged wheel on the shaft 3 feet in diameter, which gears into another of the same size, set on a small horizontal shaft at right angles to the main, planted on proper journals near the ground. Nearly under the windlass this small shaft carries a strong screw, which gears into a cogged-wheel, again 3 feet in diameter, mounted on a perpendicular iron shaft. On this latter shaft there is another strong screw, which slowly turns the large wheel of the windlass. All the iron work of this machinery, and all the wooden framing which carries it, are heavy and substantial. Ways of this size being necessarily expensive, costing usually about $100,000, few men have the capital to own them, and therefore the repair work of steamboats is necessarily concentrated at a few points.

The lower stretch of the Ohio, on account of deep water and the abundance of white oak, is well adapted both for repair work and for the building of large vessels. Alongshore, on both sides of the river, trees of large size can be had, and away up in the interior of Kentucky, accessible from the rivers, there is so much tall and fine timber that barge gunwales, keelson pieces, and plank can be got from 60 to 75 feet in length. Oak can be delivered in rafts at the several building points on this part of the Ohio for $10 to $13 per thousand in the round log, counting what can be squared from the log; for squared lumber the price was $16 and $18 per thousand in 1881. Other kinds of valuable timber exist in large supply, and poplar logs of 6 feet diameter are often rafted to Mound City, Metropolis, Paducah, and Cairo from the rivers in Kentucky. Black gum and cypress grow profusely, and an eastern sewing-machine factory has recently established a branch at Cairo to utilize the former for the cases of the machines. These great advantages for building have not yet been utilized; but when the oak disappears from the upper Ohio, and it certainly is going fast, the lower Ohio can be made the center of a great and prosperous industry. Cairo is one of the best places in the West to study the character of western tonnage. As the water is deep and the current light and there is a large trade, this town is a busy shipping point the year round. There has been for some time a grain elevator here, and the Illinois Central railroad has lately erected another of large size. When the Mississippi above Cairo is closed by ice, therefore, the grain trade of Saint Louis is directed by rail to Cairo, and barges are loaded there with the shipments to New Orleans. The town has also a coal trade, the railroads giving access to the great Illinois coal-fields. Cairo is a port of call for all the steamers of the two rivers, and vessels of every class float by its doors and lie up at its wharf-boats. There have been 70 and 80 steamers in port at Cairo at one time, together with large fleets of model and coal barges. From 25 to 30 model barges lay near the elevator at the time the town was visited in 1881, hundreds of empty coal barges were moored below the town waiting for a rise of water to go up the Ohio, and many traveling shop-boats were pulled up on the bank. A number of propeller tugs built on the lakes, having been brought down to Cairo by the Illinois canal route, are owned at this place.

On the Mississippi river there is very little ship work of any class done except at Stillwater, Minnesota, Dubuque, Iowa, Saint Louis, and New Orleans, and at those places it is chiefly repairing. At the first two places facilities exist for work on river steamers and barges, and from time to time there is some building done. At Saint Louis there are six yards, and the work is almost wholly in the way of alterations and repairs. The 250,000 tons of vessel property owned in that city, with insignificant exceptions, have been built on the Ohio. Four of the six yards in the city do no building at all. Two of them have floating dry-docks, one a large marine railway, and at the fourth, which is owned by a steamboat company, there are machine-shops and floats solely for keeping the boats of the company in good order. The sectional docks can take out of the water vessels 300 feet long and 84 feet wide over the guards; that is to say, steamers of the largest size now employed in the trade of Saint Louis; but at the other dry-dock vessels of the smaller class are handled.

The marine railway is owned by the Sectional Docks Company, and is located in the southern suburbs of the city. It was started by Primus Emerson and his associates in 1856 or 1857. The original railway was made in seven sections of two rails each, each section carrying a cradle, the rails being 340 feet long from the gearing above to the lower ends in the river. A pitch of $1\frac{1}{4}$ inches to the foot was given to the ways, and heavy chains of $1\frac{3}{4}$-inch iron ran from the cradles to a long line of shafting placed under a rough shed on top of the bank. Emerson found that in hauling out long vessels an unequal strain was imparted to the several chains, as the cradles directly under the boilers and engines took the most weight, and that one chain often broke and it was impossible to equalize the pull. To remedy this in part he conceived the idea of detaching the chains from the front corners of the cradles and of carrying each set down through and around the cradles over friction sheaves, so that each cradle lay in the bight of the chain. The original railway cost $120,000; but it was afterward enlarged, by the addition of two more sections, so as to be able to take out 360-foot vessels, and its value was then rated at $250,000, its capacity being such that five steamboats and barges have been out at once on the bank undergoing alteration and repair. In the East, where vessels are pulled up endways on the bank, only one hauling machine or set of gearing is required; but here there are nine machines located on the top of the bank, arranged in a long row under the shed, each machine placed opposite a section of the railway. Power is communicated to the several sets of gearing by a main driving-shaft 390 feet long and $7\frac{1}{2}$ inches in diameter. This shaft runs out from the boiler and engine house along the surface of the ground at the top of the bank parallel to the river, and rests on journals strongly secured to wooden logs and piles. Opposite each set of gearing there is a strong cog-wheel on the shaft 50 inches in diameter, with cogs 2 inches thick, $2\frac{1}{2}$ inches high, and 6 inches from center to center, which drives that set of hauling machinery, and as the machines are driven by a common shaft they work in unison. The machines are strong, but simple in their arrangement. There is, first, near the ground, and resting on heavy oak logs, a shaft 10 feet long and 9 inches diameter at right angles to the main shaft, with a cog-wheel at one end gearing into the one first mentioned and a screw about the middle of its length gearing into a large wheel hung above it on another shaft parallel to the main one. The cog-wheel is 64 inches in diameter. The screw has four threads, and is 23 inches long and 30 inches in diameter. As before stated, the cog-wheel slowly turns a large wheel (hung above it on a shaft 20 feet long, just the width of one section of the railway) 12 feet in diameter, with a rim 3 inches thick, carrying 60 cogs 3 inches high. The shaft on which it is mounted is 15 inches in diameter at the wheel, but tapers to 10 inches at the ends, and hangs about 8 feet from the ground, being supported at the ends by a heavy framing of oak timber, which is a continuation of the wooden ways of that section of the railway. Close by the journals of this shaft are the strong little toothed wheels around which pass the cradle chains. Each set of hauling machinery can be worked independently, as on the main shaft there is a clutch which throws the cog-wheel in and out of gear at pleasure. By this means steamers can be taken up on any part of the railway. On top of the eighteen wooden ways running down into the water there are iron rails, on which the cradles run. About 300 tons of iron were consumed in this railway, exclusive of the engines and boilers.

There are two yards at Saint Louis devoted to new vessels, both started within five years. One is managed by United States engineers, who employ a few men in making flats, lodging-boats, snag-scows, etc., for the Mississippi river improvements; the other makes iron tug-boats, launches, snag-boats, and steamers, and has done something in the way of altering various iron gun-boats of the late war into merchant steamers. This yard will be referred to more fully under the title of iron vessels.

The tonnage of Saint Louis consists of about 170 steamboats (including a few propeller tugs), registering 61,000 tons; 250 model barges, registering 181,000 tons; about 25 flats, 2,600 tons; and from 16 to 20 wharf-boats. Her fleet includes few coal barges, and all her tonnage is of the finest class. Several companies here have been engaged in the shipment of grain to New Orleans, and by a recent consolidation and the giving out of new contracts they have created a fleet of 23 tow-boats and about 150 model barges, by means of which 9,000,000

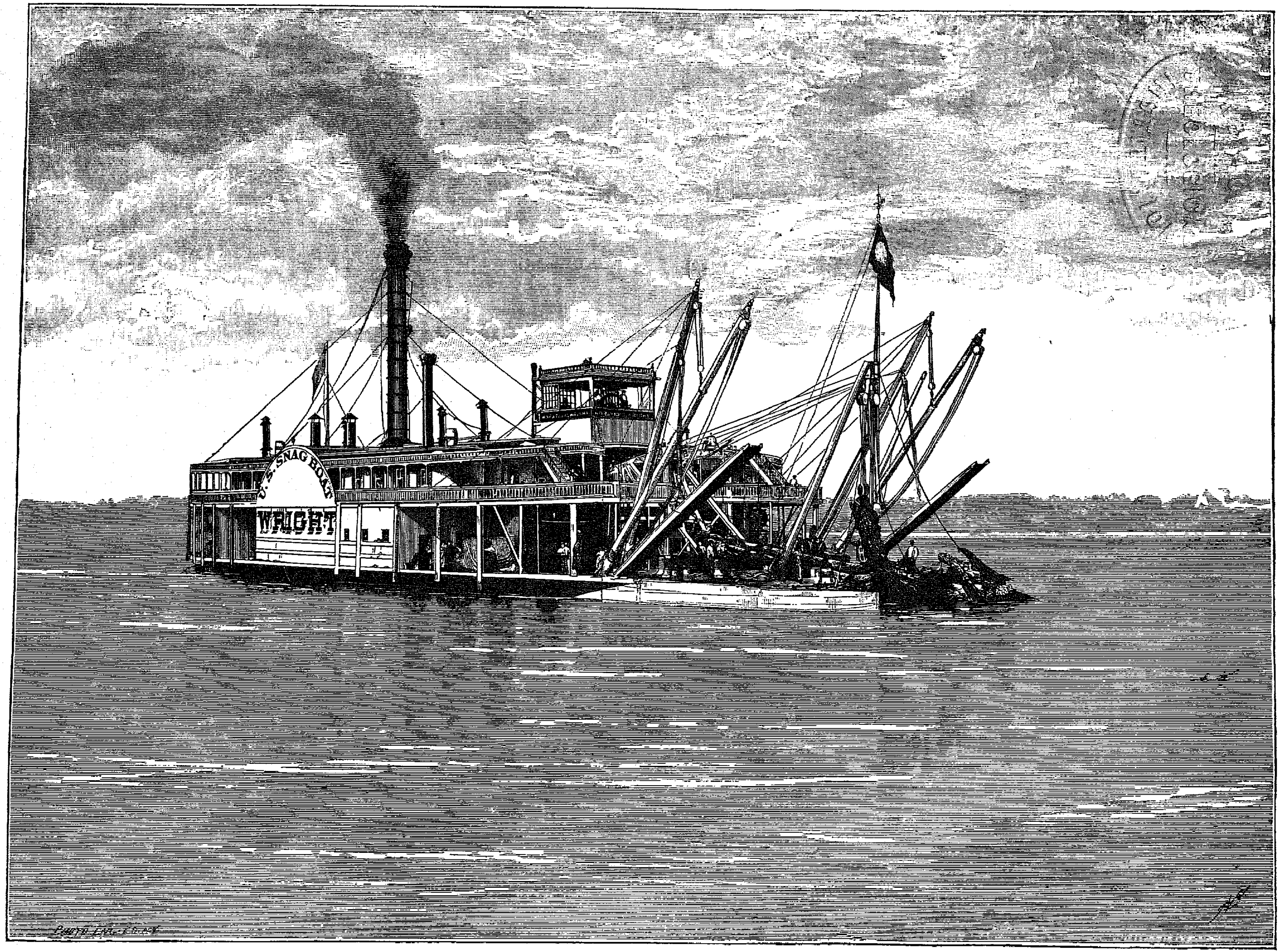


Fig. 62.—United States iron snag-boat Horatio G. Wright.

187 feet long, 62 feet beam, 90 feet wide across the guards, 8 feet hold.

bushels of grain can be shipped on a single trip. The present fleet of Saint Louis, of all classes, will wear itself out in six years, requiring the building of 40,000 tons of vessel property yearly to maintain it up to the present capacity, and there is a yearly increase in the grain trade. At present the ship-building talent, the skill, and the capital of western boat-building are mainly on the Ohio. On the other rivers, especially those westward of the Mississippi, there is at this time for the most part only the raw material; but this exists so abundantly, and is so cheap and good, that it would seem to afford a valuable opportunity to the people of Kentucky, Missouri, and Arkansas, the three states named being full of valuable oak, poplar, cypress, and black gum. The price of oak now ranges from $12 to $15 per thousand in the round log, delivered in the rivers. In other parts of the country suitable lumber is rapidly disappearing. There is water all the way from New Orleans deep enough to float out merchant sailing vessels and wooden propellers of any size now required in the coasting and the transoceanic trade, and the weather would permit work to go on twelve months in every year, whereas three months are lost on the Ohio on account of snow and ice.

There is some work at points below and west of Saint Louis. This work consists usually of the construction of small craft for local use, generally as ferry-boats or for short river routes. There are few or no regular yards, and the work is generally performed by house carpenters or amateur mechanics under the supervision of some competent shipwright. The points where small vessels are thus constructed from time to time are Lisbon, Glasgow, Missouri City, Kansas City, Leavenworth, Saint Joseph, Plattsmouth, Little Rock, Fort Smith, Poplar Bluff, and perhaps other places. At Memphis only repairing is done, but New Orleans occasionally builds small river steamers.

There is no building of vessels on speculation in the West, as there has been on the sea-coasts, nor do owners practice building for themselves. Keeping the management of their tonnage in the hands of their families is entirely unknown, the only thing approximating the latter feature of the Atlantic coast being the construction of their own flats and barges by a few of the Pennsylvania and West Virginia coal companies. Steamboat building is done entirely by contract with professional shipwrights, and barges are generally built in the same way. The rule for payments on contracts varies somewhat in different localities. The old rule before the war was half cash during the progress of the work, a payment being made at the beginning of the work and other payments at intervals; the other half of the stipulated price was paid in 4 and 8 months, or 3, 6, and 9 months after completion, security being required where the responsibility of the owners was not clear. On account of the credit system Ohio river men lost a good deal of money when the war of 1861 broke out. Since the war an effort has been made to bring the business nearer to a cash basis, but the custom still prevails of reserving one-third or one-half of the contract price until the completion of the boat. Builders buy their materials in about the same way, partly on time.

SNAGS.—While the danger of wreck from running against snags is now the chief peril to which boats are exposed builders have made little or no attempt to fortify their vessels against it, and there appears to be no way of doing it except by adding excessively to the weight of the hulls. The scantling of all boats is indeed made a trifle heavier forward, and the frames there are put in nearer together; but this is as much for helping the boat when it runs against the bank or upon a sand bar as for any other reason, and the light hulls are virtually left unprotected against snags. The lower part of the Mississippi below Cairo has always been dangerous on account of these destructive obstacles to free navigation. Wherever a bank washes away, full-grown trees fall into the water and float down stream until their roots become lodged on the bottom. The current swings the top of the trees down stream, and in time the action of ice and floating *débris* wears away the branches and even sharpens the points of the trunks. About one-half of all the losses of steamers are due to running against these formidable stationary rams, and the only way to remove the danger is to take out the snags. Organized work to that end goes on yearly under the supervision of the United States government, and boats are built especially for this service. They are stern-wheelers, with houses large enough to shelter the machinery and provide accommodations for the working force. The bow is broad, square across the boat, and plated with iron. The snag is felt for and caught with an iron chain hanging in a loop from the bow. It is then raised with a powerful derrick and windlass worked by steam, and is either dragged upon the deck of the steamer itself or hoisted out upon a flat-boat lashed alongside. The trunks are often 5 feet through and 60 feet long, and their average weight 17 tons, from which it will be seen how powerful is the machinery required to dislodge them from their anchorage in the soft bottom of the river and to lift them out upon the boats. Major Suter, of Saint Louis, has supplied the following memorandum of the operations of the snag-boat H. G. Wright (Fig. 62) in the one year of 1881 during eight months of work: Total number of snags destroyed, 1,909; number of trees cut on banks liable to cave into the rivers, 5,005; number of drift piles removed, 15. The following is a statement of the work done on the Mississippi, Missouri, and Arkansas rivers from March 28, 1868, to June 30, 1881, also supplied by Major Suter:

Rivers.	No. of snags pulled.	No. of trees cut.	No. of drift piles removed.
Mississippi	14, 582	54, 605	107
Missouri	13, 309	47, 042	335
Arkansas	5, 083	8, 059	76
Total	32, 974	109, 706	518

The removal of these trunks has probably saved a loss of from $500,000 to $750,000 of vessel property a year.